University of Oregon

Medical School

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THE CHILDREN OF

DR. KENNETH A. J. MACKENZIE

THE

PRINCIPLES OF MEDICINE.

BY

JOHN M. SCUDDER, M. D.

PROFESSOR OF THE PRINCIPLES AND PRACTICE OF MEDICINE IN THE ECLECTIC MEDICAL INSTITUTE OF CINCINNATI; AUTHOR OF "A TREATISE ON THE DISEASES OF WOMEN," "THE AMERICAN ECLECTIC MATERIA MEDICA AND THERAPEUTICS," "THE ECLECTIC PRACTICE OF MEDICINE," "SPECIFIC MEDICATION," "SPECIFIC DIAGNOSIS," "ON THE USE OF INHALATIONS," ETC., ETC.

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PREFACE.

MEDICAL teaching has been very crude and imperfect in practical medicine, from the want of a proper systemization of facts, and the development from these of pathological and therapeutic laws. In place of this we have been presented with the theories of closet practitioners, and the vagaries of dreamers, who were always more persistent in making known their views than the modest toiler by the bedside of the sick, in the dead-room or in the laboratory. There has, however, been a great change in this regard within the last quarter of a century; and men now value the facts of observation more than the conclusions arrived at by reasoning from imperfect data. Thus, the practice of medicine has attained such development that it may be regarded as a *science*.

Webster defines science to be "a collection of the general principles or leading truths relating to any subject, arranged in a systematic manner." In order, therefore, that the practice of medicine should be termed scientific, it is necessary that there be certain well-defined truths, and that these be so grouped together as to establish fixed principles.

Many deny that there is any science in the practice of medicine, and only admit it in chemistry and anatomy, out of the seven branches taught in our colleges. Others, and among these our best writers, while claiming that medicine is a science, almost entirely ignore it in practice, and in writing results are given as almost entirely or quite empirical. That practical medicine is an art to be studied, and perfected by continued practice, must be admitted, but I claim that there is an underlying scientific basis that needs to be known to give the greatest success. The empiric may have success, but it is only after he has generalized his observations, and formed in his own mind, certain definite principles. The man who has this power in a great degree, has great success, while the

man who has it not, will not succeed. Any physician may prove the truth of these propositions by looking into his own mind and tracing the process of reasoning by which his practice is governed.

If these are facts,—and no person who looks at them dispassionately can doubt them,—we can easily see the importance of the teaching of those generalizations of truths which form *laws* in practical medicine. Having mastered this, the student commences his practice with definite principles, and his observations being properly directed, his experience is more valuable. He commences, in fact, so far as regards this, at the point where the empiric would leave off after ten or twenty years practice. It is true that it is very difficult to get that thorough study from the medical student which will enable him to master the subject, and yet if presented in its simplest form he will see a beauty in it that will excite to deeper study.

While I would ask the indulgence of the reader for many imperfections and short-comings in this volume, I am certain that he will find the facts correctly stated, and the conclusions legitimate; neither distorting the first from prejudice, nor wresting the second to prove a favorite theory. The object has been to so generalize the facts of physiology and pathology, as to give a sound basis for a rational practice of medicine. If it serves this purpose, and gives efficient aid to the student in this difficult department of study, the author will be fully recompensed for his labor.

TABLE OF CONTENTS.

CHAPTER IV.

CHAPTER VI.

CHAPTER VII.

THE PRINCIPLES OF MEDICINE.

INTRODUCTION.

ANY variation from the standard of healthy function or structure is *disease*. Human Physiology is the study of the *state* and *activities* of the body in health; Pathology is the study of the *state* and *activities* of the body in disease. To study Pathology to advantage, therefore, it is necessary that the student be conversant with the facts and principles of Physiology, and to make a practical application of this knowledge, that he shall have verified those which are cognizable to our senses by personal observation. In this manner he establishes in his own mind a standard of comparison, and is enabled to determine variations from this.

The various functions of life in *health* have certain uniform expressions, through the nervous and motor systems, which thus give evidence of the state of the individual, while the physical properties of the various tissues have a uniform standard, representing health. In the same manner the phenomena of life in disease have certain expressions termed *symptoms*, which give evidence of the pathological state of the entire body, or of its parts. And the change in the physical properties of parts determines structural lesions.

circulation we use direct or indirect sedatives, which diminish the frequency of the pulse and give a uniform circulation. By the use of baths we diminish the heat. If necessary, there are means which lessen the excitement of the nervous system. The defect of excretion is remedied by diaphoretics, diuretics, and cathartics, which increase the functions of the principal emunctories. And the defect of digestion and nutrition is remedied by the use of bitter tonics, restoratives, and nutritious food, which increase these functions. And lastly, the perversion of the blood is remedied by the use of quinia for the malarial miasm, or the use of sulphites, chlorates, or some mineral acids, when it is an animal miasm or effete matter.

There are two special advantages in studying disease in this way: First, we obtain a correct estimate of the extent and kind of diseased action, and the particular parts affected, and are not so liable to be led astray by the meaningless names of the old *Nosology*. Second, a rational therapeutics is at once suggested, as the disease is analyzed by the rule of excess, defect, and perversion.

The principal difficulty we meet with in our study of Pathology is the uncertainty of the physiological standard; not that there is not a well developed system of Physiology, but that most authors are influenced to some extent by the crude theories of past centuries, to which they endeavor to make facts conform. ... Carpenter's Human Physiology, aided by the investiga- ... Huxley and Chambers, and would suggest the study of ... reader.

... fication of subjects is always of advantage in ... it can be made to lead naturally from first ... t of the subject. I do not know ... ble in the present state of the ... not attained it.

The method I have adopted considers the subjects in the following order:—

Forces operative in animal life		Formative or vital. Heat. Electricity.
Animal cells. - - -		Formative. Secreting. Necrological.
Nutrition. - - -		Food. Digestion. Cell-growth.
Secretion. - - -		Recrementitious. Excrementitious.
The blood. - - -		Red and white corpuscles. Albumen. Fibrin. Fats. Salts. Excreta. Water.
The influence of morbid material and miasms on the blood.		
The lymph and its circulation.		
Circulation of the blood.		General. Local.
Inflammation.		
Innervation.	Brain.	Reason. Emotions. Volition. Sensation.
	Spinal cord.	Automatic movement. Sympathy.
	Sympathetic ganglia.	Control of vegetative functions.
Contractile fiber.		Irritability. Tonicity.

If we make ourselves masters of the physiology of these functions, so as to know the structure of the animal mechanism, its mode of action, the causes that influence it, and the results attained, we have the theoretical knowledge necessary to the study of Pathology; and if we are enabled, by previous observations, to determine each of these in the living body, we will be enabled to make a practical use of Pathology in diagnosis and therapeutics.

As I will make frequent reference to the classification of Dr. Williams, in the progress of the work, I append it here. It will be found in this, that the lesions of excess, defect, and perversion are noted, and the results named. In this classification, the elements of disease are considered in two classes, *primary or ultimate elements, and secondary or proximate elements.*

PRIMARY ELEMENTS OF DISEASE.

STRUCTURAL CONSTITUENT.		ITS FUNCTION.	STRUCTURAL DISEASE.
Contractile fiber.		Irritability. Tonicity.	Excessive, hypertrophy. Deficient, atrophy. Perverted, degeneration.
Nervous structure.	Tubular (the conductor of nerve force.) Vesicular (the generator and combiner of nerve force.)	Sensation. Voluntary motion. Involuntary motion (excited motor action.) Sympathetic action.	
Secreting structure.		Secretion.	
Elementary components of blood.	Red corpuscles. White corpuscles. Fibrin. Albumen. Oil and combustive matters. Inorganic ingredients. (saline and mineral.) Water.		
Elementary changes in the blood.	By respiration. By secretion. By nutrition. By foreign matter.		

PROXIMATE ELEMENTS OF DISEASE.

The circulating blood.	Deficient in quantity, anæmia.	General. Partial.		
	Excessive in quantity, hyperæmia.	General, plethora.	With Circulat'n	Increased, sthenic. Dimin'ed, asthenic.
		Partial, local hyperæmia.	With Circulat'n	Increased, determination of blood. Dimin'ed, congest'n. Partly inc. Partly dim. inflammat'n.
	Perverted in quality, cacæmia.			
Nutrition of textures.	Deficient, atrophy.			
	Excessive, hypertrophy.			
	Perverted,	Degeneration of tissues. Morbid deposits. Morbid growths.		

—*Principles of Medicine, pp.* 96, 97.

CHAPTER I.

LIFE.

1. In our endeavors to elucidate those principles which should underlie a rational practice of medicine, it is necessary that we examine, so far as we can, that which is called life. It will readily be seen that this should take precedence of *function*, which is only a manifestation of life.

2. But we are met at the threshold of our inquiry by two classes who ridicule such investigation, and by this means have retarded the development of correct doctrine. The one claims that the chemical and physical forces observed in nature are sufficient to account for all the processes and phenomena of life; consequently that in a true physiology the whole series of vital operations is to be explained upon chemical principles. Not only so, but that the laws of disease and of therapeutics are to be evolved in the same manner.

3. The second claims that, life being beyond our knowledge, intangible to our senses, and not, therefore, susceptible of reason, it is useless to speculate upon it. With these there are various shades of opinion—some leaning to the chemical theory, others to the supernatural, or the *Source of all power*. Dr. Draper, in his Human Physiology, attributes life to the soul—"a self-conscious and immortal principle which animates this machine."

He says further, that the physiologist "can not but recall with regret the existing use of many terms, such as mind, intellect, vital principle, and spirit, which, though they were at first

doubtless employed as expressions of the functions or qualities of the soul, have, in the course of time, gathered other meanings and confused the popular ideas." . . . . "On one of these terms, the vital principle, I may make a few remarks, since, from being a mere expression of convenience, it has by degrees risen among physiologists and physicians to the rank of designating an existing agent, by some regarded as of the same kind as light, heat, electricity, or gravitation—nay, even superior to these, since it is its peculiar attribute to hold them all in check. Animated by this extraordinary power, organic substances are supposed to withstand every external influence, and to submit to physical agents only after this principle has left them. Such a preposterous doctrine will not bear the touch of exact science for a moment. It is only a relic of the old metaphysical system of philosophizing, which accepted a name in lieu of an explanation, which preferred the dogma of the horror of a vacuum to the more simple view of the pressure of the air."

4. It is true, however, that there is *organic life*, and every one has the evidence of this in his own person, and as he is brought in contact with it throughout his existence. Whatever it may be, and whatever relations it may bear to other forces in nature, it stands at the threshold of our inquiries, and we can not pass it by without examination. Before giving my own views, I will briefly present those of other writers which have claim to our consideration, and which will pave the way for certain definite axioms.

2. Going back to the year 1744, we find Swedenborg, one of the most accurate observers and correct reasoners of the eighteenth century, presenting the matter in this form: "There is a certain formative substance or force that draws the thread from the first living point, and afterward continues it to the last point of life. With respect to this formative substance or force, such is the defect of terms that we can predict scarcely any thing of it except that it is the first, the most perfect, the most universal, and the most simple of all the substances and forces of its kingdom; and that it has assigned to it, within its own little corpo-

real world, a certain species of omnipresence, power, knowledge, and providence. The first ends, as well as the middle and ultimate ends, according to which causes follow in provisive and given order till they arrive at the ultimate effect, appear to be present to it, and inherent within it, simultaneously and instantly. Consequently, this substance or force represents to itself the state about to be formed, just as if it were a state already formed; and, indeed, the state already formed as a state about to be formed. Moreover, the series of all the contingents, in the order in which they successively appear for the purpose of completing the work of formation, is instantly present to it, and, as it were, involved within it.—*Economy of the Animal Kingdom, page* 221.

6. *Stevens on Life.*— "It is difficult to define life, for we know not what it is; and this is the secret, of all others, that nature will be most likely to keep to herself. We may give it a name, however, and call it what we will; but the very existence of this mysterious essence, like the cause of heat, is known only by its obvious effects. But these effects are evident to all; we know, for example, that this is the cause which constitutes the difference betwixt the living and the dead body, and the loss of which is the cause of death. We know that, for a time, it endows matter with certain properties—such, for example, as the power of self-preservation. It enables all living animals to resist, within a certain range, the effects of noxious agents, as well as those chemical and other changes that would be injurious to life. It enables them not only to provide for, but to regulate, their own temperature. But, even independent of the property of evolving heat, it enables a living animal, in a certain degree, to resist the effects of extreme cold. It is this which enables the blood, when it forms the new solids in the living body, to organize itself; it is this, also, which endows the whole of the animal creation with the power of communicating vitality to their offspring, and each in return to continue the existence of their own race. Such are some of the characteristics of life;

and the blood is as essential in the production of these phenomena as either the brain, the nerves, or any of the solid structures of the animal economy."—*Observations on the Blood*, page 120.

7. *Carpenter on Vital Force.*—"A strictly scientific inquiry, then, *must* recognize dynamical agency as well as material condition; and it will be found that this is peculiarly requisite in the science of life, which has been pursued by some as if it were a sufficient account of every phenomenon not otherwise explicable, to refer it to a 'vival principle;' while others have endeavored to reduce all physiological causation to a set of material conditions, maintaining that life entirely depends on 'organization,' and that the hypothesis of a vital principle is consequently unnecessary and unphilosophical. Others, again, who have recognized the operation of physical and chemical agencies in the living body, have maintained that all vital action is but a peculiar manifestation of heat, mechanical power, chemical affinity, and the like; and have thus attempted to break down the barrier between the organized and inorganic creation. The author has elsewhere endeavored to show that we have evidence of the operation of a *power* in the living body, whose manifestations are so different from those of the physical forces, that we can not reasonably refrain from giving it a distinctive designation; and that this 'vital power' may exert itself in a great variety of modes, and consequently may produce a variety of phenomena, according to the material conditions of its operation, just as (though the comparison be somewhat clumsy) the mechanical power which turns the engine-shaft in an extensive factory is rendered efficient for an immense variety of purposes, according to the construction and arrangement of the several machines through which it is distributed. And further, he has attempted to prove that the source of this vital power is to be found, not in the organization of the being itself, but in the forces which operate upon it *ab externo;* and that it has the same close and intimate relation with the heat, electricity, chemical affinity, and other agencies of the inorganic world, which they have been

proved to have with each other; so that, just as heat acting upon water generates mechanical force, or when applied to a certain combination of metals, electricity—so when brought to bear upon a torpid animal or upon a seed (in which the material conditions of this activity are present), it manifests itself as a vital force, and is the immediate dynamical condition of the phenomena of growth, development, etc. (See further, pp. 140 to 148.) —*Human Physiology*, p. 36.

8. *Liebig on Vital Force.*—"In the animal ovum, as well as in the seed of a plant, we recognize a certain remarkable force, the source of growth, or increase in the mass, and of reproduction, or of supply of the matter consumed—a force in a state of rest. By the action of external influences, by impregnation, by the presence of air and moisture, the condition of static equilibrium of this force is disturbed; entering into a state of motion or actictivity, it exhibits itself in the production of a series of forms which, although occasionally bounded by right lines, are yet widely distinct from geometrical forms, such as we observe in crystalized minerals. This force is called the *vital force*, or *vis vitæ, vitality.*

"In the vital process, as it goes on in vegetables, it is exclusively inorganic matter which undergoes this decomposition; and if, with the most distinguished mineralogists, we consider atmospherical air and certain other gases as minerals, it may be said that the vital process in vegetables accomplishes the transformation of mineral substances into an organism endued with life; that the mineral becomes part of an organ possessing vital force.

"If the vital phenomena be considered as manifestations of a peculiar force, then the effects of this force must be regulated by certain laws, which laws may be investigated; and these laws must be in harmony with the universal laws of resistance and motion, which preserve in their courses the worlds of our own and other systems, and which also determine changes of form and structure in material bodies, altogether independently of the

matter in which vital activity appears to reside, or of the form in which vitality is manifested.

"The vital force in a living animal tissue appears as a cause of growth in the mass, and of resistance to those external agencies which tend to alter the form, structure, and composition of the substance of the tissue in which the vital energy resides.

"This force further manifests itself as a cause of motion and of change in the form and structure of material substances, by the disturbance and abolition of the state of rest in which those chemical forces exist, by which the elements of the compounds conveyed in the living tissues, in the form of food, are held together.

"The vital force causes a decomposition of the constituents of food, and destroys the force of attraction which is continually exerted between their molecules; it alters the direction of the chemical forces in such wise that the elements of the constituents of food arrange themselves in another form, and combine to produce new compounds, either identical in composition with the living tissues, or differing from them. It further changes the direction and force of the attraction of cohesion, destroys the cohesion of the nutritious compounds, and forces the new compounds to assume forms altogether different from those which are the result of the attraction of cohesion when acting freely—that is, without resistance.

"The vital force is also manifested as a force of attraction, inasmuch as the new compound produced by the change of form and structure in the food, when it has a composition identical with that of the living tissue, becomes a part of that tissue.

"Those newly-formed compounds, whose composition differs from that of the living tissue, are removed from the situation in which they are formed, and, in the shape of certain secretions, being carried to other parts of the body, undergo in contact with these a series of analogous changes.

"The vital force is manifested in the form of resistance, inasmuch as by its presence in the living tissues their elements acquire the power of withstanding the disturbance and change in

their form and composition, which external agencies tend to produce—a power which, simply as chemical compounds, they do not possess.

"As in the case of other forces, the conception of an unequal intensity of the vital force comprehends not only an unequal capacity for growth in the mass, and an unequal power of overcoming chemical resistance, but also an inequality in the amount of that resistance which the parts or constituents of the living tissue oppose to a change in their form and composition, from the action of new external active causes of change; just as the force of cohesion or of affinity is in direct proportion to the resistance which these forces oppose to any external cause, mechanical or chemical, tending to separate the molecules, or the elements of an existing compound.

"The manifestations of the vital force are dependent on a certain form of the tissue in which it resides, as well as on a fixed composition in the substance of the living tissue.

"The capacity of growth in a living tissue is determined by the immediate contact with matters adapted to a certain decomposition, or the elements of which are capable of becoming component parts of the tissue in which vitality resides.

"The phenomena of growth, or increase in the mass, presupposes that the acting vital force is more powerful than the resistance which the chemical force opposes to the decomposition or transformation of the elements of the food.

"The manifestations of the vital force are dependent on a certain temperature. Neither in a plant nor in an animal do vital phenomena occur when the temperature is lowered to a certain extent.

"The phenomena of vitality in a living organism diminish in intensity when heat is abstracted, provided the lost heat be not restored by other causes.

"Deprivation of food soon puts a stop to all manifestations of vitality."—*Animal Chemistry*, pages 11, 60.

9. *Chambers on Death and Life.*—"Man's body may be likened to a stately mansion, made of beauteous but very perishable materials, all of which are always needing repairs to keep up the shapeliness and usefulness of the building; but not all in equal degrees. Some of the walls may stand unaided for years, while other parts may want almost hourly looking after. When the owner leaves the dwelling the repairs cease, and then we see, not all at once, but one after another, the materials falling into ruin. It will serve a purpose in my argument to think over the several steps of this ruin for a few minutes.

"I began this lecture by likening the animal body to a building constructed of perishable materials, which need continuous renewal to maintain the usefulness of the structure. To keep up the simile, the permanent architect is the indwelling life, and he best performs his duty, not by fits and starts of work, but by ever-watchful industry. He should be every moment removing decaying materials from the walls and working machinery, to be carted away at convenient periods, and he should be every moment supplying their place by fresh. Thus there are two departments carried on simultaneously—the 'destructive' and the 'constructive;' and upon their harmony and completeness depend the perfection of life which we call health. Both are necessary; and the deficiency of either or both, or the preponderance of one over the other in various parts, or their deficiency in one part while other parts remain active, constitutes a deficiency of life—a disease."—*Renewal of Life*, pages 14, 28.

10. I might continue these quotations, and that, too, from authorities that have stood high in the profession, but I do not deem it necessary, as what I have given above is conclusive as to the general belief in a force superior to the chemical and physical forces that govern the inorganic world. I do not deny the action of these in organized bodies, but that in life they are subservient to another and higher power.

The relation of these I thus stated, in 1857, in a work on Therapeutics:—

"But before considering these two classes of disease, it will be advantageous to take a glance at the forces which act upon the materials of which the body is composed, producing all the varied actions of the system, both in health and disease. In the human body, as well as in all living organisms, we recognize two separate and distinct kinds of force, which are antagonistic to each other. These have been named the *vital* and *chemical* forces.

"The vital force is that power which, from the single cell, builds up the entire organism; separates from the nutritious materials furnished it those portions which form the different organs of secretion, excretion, and innervation; supplies the waste of the tissues, and tends to keep the body intact.

"But in the chemical force we recognize the cause of the waste of the body, the disintegration of the tissues, the change of matter from a higher to a lower grade of organization, and all the retrograde tendencies in the body—from a state of health to disease and death.

"Health, then, consists in the maintenance of the proper equilibrium between the vital force which builds up the system, and the chemical force which causes disorganization. Life itself is a forced state of being, caused by a preponderance of vital force, every atom of the body having a constant tendency to revert back into its original elements. This change taking place in the entire body produces *death;* in but a portion of the body it produces *disease.*

"Then any cause which diminishes the *vital* force, thereby giving a preponderance to the *chemical*, becomes a cause of disease; or any cause which increases or gives greater intensity to the chemical changes going on in the body also becomes a cause of disease, providing these changes are not antagonized by the vital force."

FORMATIVE FORCE.

11. I think, from what has been already stated, that we may make three propositions, the truth of which will not be disputed by any one—indeed, they will not only correspond with the experience, but also the reason of my readers. They are these:—

First. That there is a force in the organic world differing from chemical and physical forces, and which may be appropriately termed the *Formative Force.*

Second. That this force is not possessed by all persons in equal degree; that in some it is strong, giving health and great power to live; while in others it is feeble, consequently giving disease and death.

Third. That this force is not a fixed quantity with any individual, but that it may be increased and diminished.

12. These propositions being admitted, our investigations will be turned to those circumstances that influence this *formative force*, or power to live. As regards its entity, or whether from the spiritual or natural world, we care but little. What we are interested in knowing is, how it may be conserved, and how it may be increased when deficient.

13. *Localization of the Formative Force.*—With many this force has been thought of as having some central seat, from which it flows forth to give vitality to the body at large. That this is an error will be readily seen, as there is no individual part so constituted as to be a reservoir for, or generator of, such force. But more especially, if we study the histology of the body, we will see that it is all built upon the same plan, and of the same elements, and that each ultimate structure or cell has this formative force inherent in itself.

14. Recognizing cell growth as the ultimate formation of the body, we may safely assume that the formative force by which they are organized is the ultimate force. When we speak of force, we understand an *active* condition, and not that simple

passivity which merely resists change. Therefore in health we have continued cell activity, and in association of these histogenetic forms in the complex animal body, a combination of the force evolved, which to some extent is common to the whole.

15. *Association with other Forces.*—We are not, however, to ignore the fact that man is a microcosm or epitome of the universe, and that all the forces of nature may find manifestation in his body. There is no doubt that in the chemical processes which continually go on, there is generated much of his power as an organized being. As an example, we may regard *heat* as but a synonym for force, or as it has been tersely expressed, "*the essence of heat is motion.*" So, also, *electricity* is force whenever and wherever manifest. We may be assured, therefore, that these forces are utilized in the organic economy, and play important parts, and they are continually to be regarded as working in the same direction, associated with, and absolutely indispensable to, the higher power that we have been considering, and which is the directing and controlling force in organized bodies.

16. *This Force is not possessed by all Persons in equal Degree.*—This proposition is so self-evident that it is hardly worth our while to give it an extended consideration. We observe it in both the sick and well, and it must play an important part in our therapeutics. We see some born with but vitality enough to last a few days, weeks, or months. With others it continues life for some years, but it is an enfeebled life, and presents continued evidence of the truth of our proposition.

17. Every successful physician acts upon this, whether he has ever allowed himself to believe in *vital* force, or whether he has ever thought of the matter. There is, many times, an intuitive recognition of it, when a patient is seen, that is so strongly impressed upon the mind as to change the common treatment, discarding harsh and enfeebling measures, and substituting those of an opposite character.

18. *Conditions favoring this Formative Force.*—These may be summed up in this—*a regular and co-ordinated action of all parts of the body.* When we descend to particulars, we might examine all the functions of the body, and we would find that their proper performance was necessary to its perfection. 1. As we will hereafter see, all action is dependent upon a continued renewal of structure, and the supply of material for this may take the first place. 2. A healthy condition of the digestive organs, and performance of their function, as influencing all the material used in nutrition, is always to be looked to as conserving the formative force. 3. In the same manner it is necessary that the products of waste of tissue should be continuously removed. 4. That there be no local depots which, from disease, furnish the blood with lower or imperfectly organized forms. It is a well ascertained fact in pathology, that the simple presence of matter undergoing retrograde metamorphosis — in plainer language, *dying*—impairs the vitality of tissue. 5. An equal circulation of blood is also an important element. Whenever the blood is circulating with undue rapidity, the primary formative processes are arrested, and hence the true vital functions of the individual are impaired. 6. A regular action of the nervous system, that happy mean in which there is neither excess nor diminution, is also an important element. No fact is more prominent in medicine than that overactivity of the nervous system rapidly exhausts vitality. 7. A temperature, varying but little from ninety-eight degrees, is absolutely essential to the performance of vital processes in the human body.

19. Though we may have no positive means of determining whether an individual has sufficient of the vital or formative force, there are many circumstances by which we are enabled to give a pretty correct opinion. The development of the person, *equal* in all directions, is an important element in this calculation. Especially that tonicity of fiber, healthful and active performance of function, and vigorous respiration and circulation of blood.

20. Experience has proven that the basilar portions of the

brain have a direct relation with this formative force, and it was claimed by Dr. W. Byrd Powell that a measurement of this would determine accurately a person's vital tenacity. The measurement was made by drawing a line from the occipital protuberance to the suture between the external angular process of the os frontis and malar bone, and taking the distance between this and the external auditory meatus. If this measurement is above three-fourths of an inch, the person has vitality to reach the allotted age of man. But below one-half inch we find vital tenacity feeble; and coming down to one-fourth inch, we can safely say that the person will not live through a severe attack of sickness, nor in any event more than two or three years.

A very large number of observations during an active practice in the last twenty years, has satisfied me of the truth of these propositions, and I have no hesitation in recommending a resort to this measurement as an important element in prognosis.

21. *This Force is not a fixed quantity with any individual, but it may be increased or diminished.*—If this proposition is true, it becomes an important element in practical medicine. That it may be diminished I do not think that any one will question. There is always a diminution to a greater or less extent in disease, and those diseases are most fatal in which there is the greatest diminution.

If the reader will review what has just been said of the conditions favoring the formative force (18), he can calculate very closely how a change of these conditions will lessen it. Indeed, he will find that the calculation may be made with tolerable accuracy as to the extent of impairment. Given, loss of appetite, excitation of the nervous system, pulse 130, temperature 105° to 107°=death; and the approximation to death, in any given case, can be very accurately estimated by the change in the entire group.

22. *Any agency that violently changes or affects any natural function impairs this Formative Force.*—I desire this proposition

to be noticed, as it will be found true in all cases, and must certainly lead to a radical change in the old practice. All medicines or agencies acting in an unnatural manner—namely, contrary to function in health—reduces the power of the patient to live. In this category we will put blood-letting, active cathartics, diuretics, and diaphoretics, and those agents that impair the plasticity of the blood, mercurials, antimonials, and even iodine, and the salts of potash, soda, etc., if in large quantity. I would not say that such means might not be used with advantage in some conditions, but that they are not necessary, and in a majority of instances absolutely injurious.

23. *Conversely—Agents that look to a better performance of the principal functions of the body conserve and increase this Formative Force, and necessarily the power to live.*—In this direction therapeutics becomes exact, or, if you prefer the term, scientific; and a practice based upon this proposition is most successful. When I come to this, I am walking on familiar ground, as my practice has been based upon it for many years. And, taking my own experience with that of many others with which I am acquainted, I am satisfied that it deserves to stand as the basis of the practice of medicine.

24. Then the principal remedies may be classified thus:—*a.* Those which place the digestive apparatus in good condition and favor digestion. *b.* Those that control the circulation, giving an equal and regular circulation of blood. *c.* Those which give regular innervation and natural periods of rest. *d.* Those that establish secretion, and thus remove noxious elements from the body. *e.* Those that arrest local diseased processes. Add to this appropriate food, and the practice becomes a very perfect one. It is not necessary here to speak of specifics in medicine, as we will hereafter find a place for them when studying the different processes of life.

25. Comparing the older methods of practice with this, we find a most marked difference in our favor. Based upon such principles, the practice of medicine lessens the mortality from

ten to thirty per cent. As this point may be denied, it is well to give statistics in proof, and I will select them from authorities that stand high in the medical world. Chambers reports two hundred and thirty cases of continued fever, divided into two series:

"Of the first series (viz., those treated on general principles),

9	are entered as	Typhus, and of these there died	4
44	"	Typhoid " "	16
56	"	Of doubtful or unrecorded type	3
Total 109		Total	23

"Of the second series:

25	are entered as	Typhus, and of these there died	0
52	"	Typhoid " "	2
44	"	Of doubtful or unrecorded type	2
Total 121		Total	4

"Of these, 109 have been treated on what may be termed 'general principles;' that is to say, they took neutral salines three or four times a day, with small doses once or twice a day of hydrargyrum cum creta at first, and later in the disease, bark, ammonia, ether, and wine, when these remedies seemed required by the symptoms. Leeches and cupping were employed to the exterior of the inflamed viscera as occasion called, and food was administered at the ordinary four daily meal-times. The other 121 have been treated on a uniform plan of continuous nutrition; animal food, in a liquid form, has been given every two hours, day and night, while the patients were awake, and between every dose of nutriment a dose of hydrochloric acid. They have been sponged two or three times daily with tepid water, when the skin was hot and dry; and in a few instances, leeches or cupping have been used to the exterior of inflamed localities in the abdomen or chest."

26. Taking the statistics of pneumonia under the antiphlogistic treatment as follows: Royal Infirmary, Edinburg, 103 cases; 55 were cured, 41 died, 7 relieved. M. Louis, 107 cases; 32 died, or 1 in $3\frac{1}{3}$. Rasori, 648 cases; 143 died, or 1 in $4\frac{1}{2}$. We may

add to this the statistics of 380 cases treated in the Charity Hospital of Vienna; 85 by venesection, 106 by large doses of tartar emetic, and 189 by diet only, with the following result:

	Venesection.	Tartar Emetic.	Diet.
Cured,	68	84	175
Died,	17	22	14
	85	106	189
Per cent.	20.4	20.7	7.4
Deaths,	1 in 5	1 in 5.22	1 in 13½

27. To this I may add my own report of 64 cases of typhoid fever treated during the year 1864, strictly according to the principles named. Of these but two died, and the average duration of the disease was but 13 1-5 days. Of 78 cases of acute inflammation of the respiratory organs—pneumonia, bronchitis, and pleurisy—the average duration of the disease was 6⅗ days, and but one died. Such facts as these are the best arguments in favor of the truth of my reasoning.

28. Whilst studying formative force, we may advantageously consider the outer conditions necessary to its exercise, and under which we have healthy nutrition. These are *light*, *air*, and *exercise*, which needs be good, and without which we can not have healthy life. It is quite as necessary to look after these, in the treatment of the sick, as to prescribe drugs, and many times the cure will depend upon giving the patient these essentials of a healthy life.

29. *Light.*—It is a well known fact that light is as necessary to animal as to vegetable life, and that without a sufficient quantity and good quality disease will result. The familiar example of the potato growing in a cellar and directing its blanched stalk towards the little light which is admitted—its soft stems, delicate and fragile leaves, its feeble life, the utter impossibility of complete growth—illustrate the wrongs observed in human beings from the same cause. The child or adult confined to illy lighted rooms—rooms with windows to the north, rooms shaded by high

houses, or sometimes by trees—will certainly suffer; and when we find such cases we insist upon light for the patient. Persons who are out of doors a considerable part of the time may sleep in such rooms, and suffer but little, and this seems to have blinded physicians to the evil of want of light.

30. Reflected light is not as good as the direct rays, and sometimes it becomes especially noxious. A yellow or straw-colored wall will reflect a light which may be so exhaustive as to impair nutrition and innervation. Whilst a bright red may be so stimulant as to be injurious to persons already excited.

31. Light is frequently broken up, and persons receive the colored rays in principal part, without knowing or intending it. As these differ in their influence upon the human body, we may have disease originating or intensified by it. Green Pittsburg glass does not make a good window, unless, indeed, the persons inside require sedation. Yellow window shades, yellow whitewash, yellow paper, the yellow clay door-yard (lawn), are not conducive to good health, for the yellow rays are sedative and exhausting. Yellow clothing is also unpleasant, though persons living in malarial regions seem to have a predilection for it, yet to them it is most injurious.

32. The blue and red rays are stimulant, and when stimulation is needed, it is good treatment to look after blue, pink, rose or red surroundings, and even colored glass of these colors, by which the white rays are broken up, and we receive the ones desired. The blue-glass window of which so much has been said, is formed of alternate blue and white (transparent) glass. These panes are better set in lead, though the ordinary wooden sash will answer. If one wishes to experiment upon this, he will find that a feeble or unhealthy plant set in such a window, will renew its life, and its growth will be markedly increased. I have seen very decided benefit from its use in atonic disease, the patient requiring stimulation, whilst injury would result if it was a disease of irritation, or the nervous system was in an irritable condition. It will not do to say, use the blue-glass treatment in phthisis pulmonalis, for in many cases the patient is suffering

from irritation, and the blue light only increases it. If, however, there is feeble innervation, feeble circulation, and general atony, it will prove useful.

33. *Air.*—Air purifies itself, and is good when it has free circulation; it deteriorates when its circulation is impeded or arrested, and is befouled by dirt and the gaseous products of animal and vegetable decomposition. The good air is out of doors; quite frequently there is bad air in the house.

34. We recognize bad air by a sense of oppression in the respiratory apparatus, and by the bad odors recognized by the nose. It is very good policy for a physician to follow his nose in this matter, and if it finds an unpleasant odor, to believe that the air thus defiled is not good for the sick. It is fortunate that the physician, being most of his time out of doors in fresh air, has very acute senses, unless he blunts them by smoking, snuffing, or drinking, or by carrying about with him bad odors in the shape of dirt.

35. We recognize the fact that the sick need pure air and plenty of it, and one of the first things we see to is, that the apartment be properly ventilated. This is best accomplished by an open fire on hearth or grate, or, if we can not do better, by a stove with open doors, and not too much fire. This removes the old and foul air. Fresh air is introduced through a window lowered or raised, or, if no other means offer, by a broken light of glass.

36. Cleanliness is better than godliness in the sick chamber, and we do not propose that the air the patient breathes shall be defiled by dirt, by excretions, or by drugs, unless, indeed, these drugs be disinfectants. This is a matter that requires constant attention, as even very nice people fail to recognize the value of cleanliness in sickness.

37. In some localities exposure to night air is to be avoided, because it is surcharged with moisture, and is therefore a better vehicle for the carrying of noxious gases. The air of swamps and marshes, of newly cleared and broken grounds, and where animal matter is undergoing decomposition, is to be avoided.

38. *Exercise.*—When describing a healthy man, we say that "he is able to do a man's work, and do it pleasurably." Of a part or organ we say, "it is able to do its work, and does it pleasurably." The body is made for work, and it requires a certain amount to give activity to the formative, as well as the other forces. If exercise is not taken, we find that nutrition becomes slower, and tissues are feeble, until at last, in some cases, they are entirely lost.

39. In the treatment of disease, it becomes a very important matter to determine the need of exercise or rest, and to prescribe it with certainty. We may say with reference to diseases of atony and enfeebled nutrition, if there is no local irritation, exercise is required—the kind of exercise to be determined by the condition of the patient, the parts affected, etc. But if there is irritability of the nervous or vascular system, general rest is needed; if there is local irritation which motion increases, then there should be rest of the part. This subject will be more fully considered hereafter.

OF THE OTHER FORCES THAT GO TO MAKE UP THE SUM OF VITAL POWER.

40. As before remarked (15), I do not claim that this formative or vital force is all, but simply a part of that which moves the beautiful mechanism of the human body. While it gives the organization and keeps it in repair, as it were furnishing the perfect machine, it also provides for the utilization of the ordinary forces of nature which may be set free by the decomposition and recomposition going on in the body. Our conscious existence, and its relation with the outer world, and the muscular power by which we render nature subservient to us, have their origin in the ordinary sources of power—heat and electricity. We may, therefore, briefly consider these as elements of the problem we are trying to solve.

41. *Heat.*—To make a statement as definite and as plain as possible, I may say that heat in the human body arises from the oxidation of its own structure, and of food taken for this purpose. It is as much a process of burning as the fire which warms our rooms, and gives rise to a motive power in the same manner as the fire under a steam boiler.

42. As we will hereafter see, the waste of the human body is about equal to its weight each four months, requiring, say, 450 lbs. of nitrogenized material for its renewal each year. To this may be added 550 lbs. of ingesta, simply for the purpose of fuel, giving a total of 1,000 pounds of combustible material yearly. If heat was the only force, this would represent exactly man's motive power.

43. But, as we have heretofore seen, the formative force employing the materials furnished by digestion, and molding them into tissue, not only furnishes the material for the generation of heat, thence force, but also for the production of electricity. The sum of these forces locked up in the tissues in their growth, and set free in their retrograde metamorphosis, is sufficient for all our purposes.

44. We get a clear view of this subject in its bearing on practical medicine, by viewing the production of heat as in exact ratio to the introduction of oxygen and the burning of combustible bodies.

45. To increase the quantity of heat in the animal body, we have but to increase the introduction of oxygen; and if at the same time, sufficient calorifacient food is furnished, we have the performance of a physiological function. In those cases in which this is deficient the tissues of the body are burned—first the adipose, afterwards the connective and muscular. We observe this in phthisis, in fevers and acute inflammations, and in many chronic diseases.

46. Animal activity increases oxygenation, and in the same ratio the production of power. In the same manner special activities increase it, particularly of the circulation and of the nervous system. With a pulse of 120, oxygenatiou goes on with

great rapidity, as it does also with an excited brain, and the tissues are rapidly burned away.

47. While, therefore, in phthisis and analogous diseases we would endeavor to prevent the waste of organized tissue by furnishing a sufficient amount of combustible matter in the food, in acute diseases we would accomplish the same object by controlling the excessive activities of the circulation and of the nervous system.

48. A certain amount of heat is necessary to tissue formation, as well as to every normal action of the body. This is maintained with the greatest uniformity at a fraction above 98°. So absolute is the requirement for this temperature that we are able to say that disease exists if it falls but little below, or rises but little above this point.

49. It would not be possible for a person to live many weeks with a temperature continually reduced by but two degrees—96°. Yet we will find in many of those chronic diseases which ignorance designates as *cachectic*, that a want of heat is one of the most prominent lesions. If you examine your patient closely with reference to this point, you will find, in addition to the cold feet and cold hands, a lowering of the general temperature to the amount of ½°, possibly 1°. It is in these cases that the use of cod-liver oil has been so markedly beneficial, and occasionally the employment of those medicines that increase oxygenation. In such cases stimulants, frictions of the extremities, and that well ordered exercise which favors increased oxygenation without exhaustion, is found to be remarkably beneficial.

50. The processes of the water-cure are sometimes admirably adapted to these cases. The stimulus of water to the surface, giving a vigorous cutaneous circulation, prevents the loss of heat, while the well ordered exercise gives increased oxygenation. In some of these cases, in addition to local stimulants to the extremities, fatty inunction, with friction, is a valuable means, as stimulating the surface and preventing the loss of temperature by evaporation.

51. But an increase of temperature is also to be considered as an element of disease. No vital process can be well performed when the temperature is continuously increased above 100°, and the power to live is rapidly exhausted if continued above 105.° I doubt whether it is possible for the formative act in renewal of tissue to go on with a temperature continuously above 102°, and above 105° the formation of secreting cells is arrested.

52. Observations made in cases of phthisis pulmonalis furnish the basis of these statements. In one case, when the thermometer was used almost daily, it was found that when it indicated above 101° there was continuous loss of flesh and strength; but when it fell below 100°, and continued thus for some days, there was rapid improvement.

53. The skin is the waste-gate for the excess of heat of the human body. Many times we will find an increased temperature because this waste-gate is closed by dryness of the skin and arrest of evaporation. In such cases, of course, those means which will re-establish cutaneous action are to be resorted to; hence, in the ordinary acute diseases of the country, the importance of the hand (or sponge) bath—indeed, the utility of all baths. In my own person I have seen the temperature reduced from 103° to 98° by one hour in a wet-sheet pack.

54. But in the severer cases we must look beyond this to the oxydizing process, or burning, going on in the body. As a general rule, in diseases which have not gone so far as to be necessarily fatal, there is a very close connection between the circulation and this process of combustion. As is the rapidity of the circulation, so is the rapidity of combustion. As we now have remedies that directly control the circulation, we have here another indication for their use.

55. Attention may also be called to the injurious influence of any excited action, in cases where the vitality of the system is nearly equaled by diseased action. The excitation of the nervous system by the conversation of injudicious friends has been the cause of death in many cases of typhoid fever. Hence we are so particular to avoid every excitement, and to keep the

nervous system in a most passive condition whenever we consider a patient in danger.

56. *Treatment.*—In summing up the treatment for the wrongs of temperature, we may say, that for deficiency we think of calorifacient foods, such as can be digested; of such agents as stimulate the process of burning, as the hypophosphites of lime, soda, potash, and iron; phosphorus, arsenic, cod-oil, and some vegetable remedies that give better innervation through the sympathetic Again, we take into consideration the necessity of such exercise as will increase the respiratory function, as with dumb-bells, free gymnastics, or even practice with wood-saw, gardening, or sometimes walking;—the necessity of fresh air, and sometimes of such change of climate or altitude as will give an invigorating atmosphere. And lastly, it is necessary that means shall be employed to invigorate the skin, that the heat be retained; for if the skin is relaxed and doughy, continually moist, or has an enfeebled circulation, it will allow heat to escape, so that even an abundant supply of food and good combustion will not maintain a normal temperature. Electricity has proven a very good remedy in many of these cases.

57. When the temperature is too high, as it is in the hot stage of fevers, in inflammations, and in most chronic wasting diseases, it is essential that it be reduced before other functions can be restored. The remarkable relation between the pulse and the temperature suggests the direct means—the special sedatives, aconite and veratrum. If the pulse is small and frequent, we give the first; if full and frequent, the second. Excitation of the nerve centers is a cause of increased temperature: thus gelseminum will reduce the temperature, if there is irritation and determination of blood to the brain; rhus, if there is frontal pain, sensation of burning heat, and pinched features; the ethers and alcohol, if there is too rapid waste. The antiseptics lessen the temperature when there is zymotic disease of the blood, as indicated by the dirty or brown color of the tongue or any exudation from the body. Thus baptisia, sulphurous acid, sulphite

of soda, muriatic acid, and chlorate of potash, when indicated, will reduce the temperature in a very marked manner. Quinine and the other cinchona alkaloids will reduce the temperature in febrile diseases, and sometimes in other cases, if the dose is large, but this last action is to be avoided. Salicylic acid and salicin also reduce the temperature in sóme cases, especially in rheumatism. The diuretic salts, if they act kindly on the kidneys, lessen the temperature, as do acids when they are indicated.

58. The direct application of cold, as by the wet-sheet pack, lowers the temperature of the body, and in some cases, strange as it may seem, the hot pack exerts a similar influence. Evaporating lotions are favorite means of removing heat from a part. All baths which place the skin in better condition for the performance of its functions, and all remedies that produce a freer cutaneous secretion, will lessen the heat.

59. An unequal distribution of heat is quite as harmful as either its excess or deficit, and is always to be rectified if possible. In low fevers, cold feet, knees, or hands, is a very unfavorable symptom, and if it continues will give a fatal termination. A hot head is not only unpleasant in acute, but also in chronic disease: good functional activity can not be expected from the brain within. A patient with chronic disease, whatever its character, will not recover if the feet are persistently cold.

60. In examining these cases carefully the right treatment will be suggested. It may be stimulant frictions to the cold parts, simple friction, the application of heat, the application of cold water and the re-action that follows, the use of electricity, etc.

61. *Electricity.*—The facts in regard to the production of electricity in the human body have not been sufficiently developed to be of much aid in therapeutics. The fact that no chemical change can occur without the production of electricity is well known, and from this we conclude that it must form an important element in life—for, as we have already seen (48), the extent of these changes is very great, amounting in the aggregate to three times the weight of the body in each year.

62. In certain fish the production of electricity is so great that it has been carefully studied. "The electricity produced by these animals possesses all the properties of electricity, such as we develop it by artificial means. Sparks may be drawn from the fish; steel needles may be magnetized; water, nitrate of silver, iodide of potassium, may be decomposed by it; and the needle of a galvanometer, when brought into the circuit, will immediately suffer a considerable deflection, so that it is easy to determine the direction of the current. *The quantity of electricity liberated in these fishes is in direct proportion to the energy of circulation and respiration of the animals.* After they have given numerous and powerful shocks they require a long rest and much nourishment, to enable them to store up again a new amount of galvanic force.—*Althaus.*

63. In speaking of animal electricity, Prof. Youmans remarks: "As it is now admitted that no chemical change can occur without electrical excitement, and as the human body is a mass of rapidly changing chemical materials, it must be a theater of extensive electrical movements, though to demonstrate this has been one of the most delicate and difficult problems of science. The blood is an alkaline liquid, while the juice of flesh is acid, and the two liquids are only separated by the thin walls of the vessels. By the action of these fluids there must be in every mass of muscle myriads of electric currents. Matteucci has proved that currents of electricity are always circulating in the frames of all animals, and that a positive current is continually passing from the interior to the exterior of a muscle. The smallest shreds of muscular tissue have been proved by Dubois-Raymond to manifest currents, the longitudinal section being always positive to the transverse section. By arranging a series of half thighs of frogs, alternately connecting the exterior and interior surfaces, he obtained a current that decomposed iodide of potassium, deflected a magnetic needle 90°, and caused the gold leaves of an electroscope to diverge."

64. Those interested in the study of animal electricity will do well to consult Carpenter's Human Physiology, pp. 633 to 640.

from the last paragraph of which I will quote, as tending to prove certain conclusions which I will make:

"The electricity of man is most frequently positive, and irritable men of sanguine temperament have more free electricity than those of phlegmatic character. The electricity of women is more frequently negative than that of men. There are persons who scarcely ever pull off articles of dress which have been worn next the skin, without sparks and a crackling noise being produced; especially in dry weather, when the electricity of the body is retained, instead of being rapidly dissipated as it is by a damp atmosphere. The effect is usually hightened if silk stockings and other silken articles have been worn, since these act as insulators. It is doubtless in part attributable to the friction of the articles of dress against each other and against the body; but we can scarcely doubt that it is partly due to the generation of electricity in the body itself, since it bears no constant relation to the former of these supposed causes. Thus a Capuchin friar is mentioned by Dr. Schneider, who, on removing his caul, always found a number of shining, crackling sparks to pass from his scalp; and this phenomenon continued still perceptible after a three weeks' illness. The most remarkable case of the generation of electricity in the human subject, at present known, was recorded some years since in America. The subject of it, a lady, was for many months in an electric state so different from that of surrounding bodies, that whenever she was but slightly insulated by a carpet, or other feebly-conducting medium, sparks passed between her person and any object she approached; when most favorably circumstanced, four sparks per minute would pass frem her finger to the brass ball of the stove at the distance of 1½ inch. From the pain which accompanied the passage of the sparks, her condition was a source of much discomfort to her. The circumstances which appeared most favorable to the generation of electricity were an atmosphere of about 80°, tranquillity of mind, and social enjoyment; while a low temperature and depressing emotions diminished it in a corresponding degree."

65. We may safely assume that either an excess or defect in the

amount of electricity will produce disease, though we have not that definite knowledge here that we have in the case of heat. It is named that a dry atmosphere tends to its retention, while a damp atmosphere reduces it; and that it may be retained by non-conducting clothing, and its removal facilitated by clothing that is a good conductor.

66. I am very confident that much of the suffering in our public schools is to be attributed to a change in the normal electrical condition of the children, by being in an atmosphere rendered abnormally dry by the use of stoves and hot-air furnaces. The symptom in these cases is a morbid erythism of the nervous system, in addition to the bronchial disturbance. The remedy is simple, and should always be applied—the evaporation of water by the heating apparatus.

67. We can also see how some persons may be benefited by keeping them in a dry, warm atmosphere, by the wearing of silk and woolen under-clothing, and by the use of glass insulators to the bed. Neither are we to regard the position of the patient, due north and south, as of no importance in feeble persons, as the great electric currents are in this direction. If a coil of copper wire, suspended so as to be movable, will arrange itself north and south, showing the direction of the magnetic influences, we may well suppose that in certain conditions of the system health might be dependent upon a proper position in this regard.

68. Dry frictions with flannel or silk increase the electricity of the body, and sometimes afford great aid to treatment. While in those cases in which there is an excess, sponging with water removes it. There are certain medicines which undoubtedly increase the electricity of the body, as there are some that reduce it, but these have not been sufficiently studied. My colleague, Prof. King, has long held to this opinion, and believes that he has had much success in the selection of remedies with regard to this point.

69. Animal electricity bears an intimate relation to the *odforce* of Reichenbach, if it is not the force he speculated upon. As some persons possess it in greater degree than others, we have no

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reason to doubt that it can be transmitted from one to another. Experience teaches us that it is not well for a child to sleep with an old person, or with one that is feeble or diseased, and it is likely that we have here the means of accounting for it. The mysterious powers of the magnetizer, that relieve pain and cure disease, may influence the person in this way, besides acting upon his credulity.

70. The use of permanent magnets, it has been claimed, exerts a marked influence upon disease in some cases. The armature being removed, the magnet is passed lightly along the surface of the body, in the direction of the nerves. If a stimulant influence is wanted, it is passed from the nerve centers to the part; if a sedative influence, it is passed in the opposite direction. Similar good effects are sometimes obtained by friction with the hands, especially if the operator have the magnetic power in a high degree. But in this case the downward passes are sedative to the brain, and the upward passes tend to rouse it to action—the hands merely touching the body, or but a little distance from it.

71. Physicians have regarded the old use of "*metallic tractors*" as charlatanry, and it is named as one of the most wonderful medical frauds ever practiced. Whilst there is no doubt that it was in the main a deception, there must have been some truth at the bottom of it, for we have had a recent revival of it by men in good standing in the profession, as shown by the following quotation:—

"There is no abatement of interest in the subject of 'metallo-therapeutics,' and enthusiastic scientists are continually taking up the matter and producing wonderful results, which, it must be confessed, do not seem to be the clumsy conjuring that some think them. Whatever opinion may be held as to the meaning of these effects of metallic applications, it is of prime importance to note that their study is not undertaken by clever charlatans, but by men of known powers of observation. One of the most recent accounts of the effects of metallic therapeutics is that of M. Abadie in a short paper on Hysterical Amblyopia (*Prog.*

Med. July 13th, 1878.) He points out that many cases of so-called 'congenital amblyopia,' when vision is not wholly abolished, when the failure is chiefly in the center of the field, and when the duration of the amblyopia may be almost indefinite, depend on anomalies of refraction, others on congenital defect in the optic nerve, whilst others are more strictly of the hysterical type. He further points out that hysterical amblyopia is not always associated with prominent hemianæsthesia, nor with the pronounced symptoms of grave hysteria, but is often almost the only functional derangement present. Three cases of so-called congenital amblyopia, which he had recently seen, proved to belong to the hysterical category; they were associated with some hemianæsthesia, the loss of sensibility being limited to the side of the amblyopia (which is almost invariably unilateral.) Applications of gold to the temporal region of the amblyopic side not only increased the acuteness of vision, but was accompanied by a diminution in that of the unaffected eye. A similar transference of sensation was observed with regard to the cutaneous sensibility. It is a phenomenon first pointed out by Charcot, and is one of the most remarkable facts in the observations of these cases. M. Abadie has found that in cases of this class which are truly hysterical, the effect of metallic applications is very striking. Thus there are cases in which continuous headache, neuralgia increased by the least work, and not yielding to quinine, have been cured by the simple means of application of a metal. Gold is the first metal to be tried. Three twenty-franc pieces are tied on to the forehead, and kept there during the night. If relief comes with the morning, then the metal is administered internally in the form of the chloride, at a dose of about a centigramme. Should gold fail, then copper, zinc, or combinations of metals are tried, until eventually a cure is effected."

72. The small discs of copper and zinc alternated, connected by insulated wire, as in the Pulvermacher apparatus, is sometimes an excellent method of applying electricity as a stimulant. At times we make the elements two or three inches in diameter,

and apply them on opposite sides of a part when we wish to stimulate absorption. And occasionally these larger elements are applied to the spine, or it may be, carried from the upper spine to the feet by insulated wire. An abdominal support with the one metal plate applied to the spine and the other to the abdomen, has been thought beneficial.

73. The medical use of electricity requires further study than we can give it here, and yet a few paragraphs on the subject may be profitable, by stimulating further investigation. There is no doubt but that if we are to use it in a rational manner, we must have a clear idea of the innervation of the body, the distribution of the nerves, and of the physics of electricity. Many persons seem to think that if they purchase a battery the necessary information will come with it, or if not, they may evolve it from their inner consciousness. Some seem to believe that it makes little difference whether one has knowledge of these matters or not, as the influence is mental (imaginary), and simple "shocking the patient" is all that is required. It is well to know, however, that this, like other medicinal measures, may do harm as well as good, and if we are to use it with advantage, it must be an intelligent use.

74. We start with the proposition that when anything in medicine has a scientific basis, it is well to learn it as a commencement. Thus the proposition that electricity may be produced by friction, by chemical decomposition, and by a permanent magnet—Franklinic, Galvanic, Magnetic—needs be understood, and especially that the Galvanic current gives us the agent in its most desirable form.

75. The second fact is, that galvanism has quantity and intensity, two very different things in therepeutics. Quantity is in proportion to the size of the plates—intensity in proportion to their number; if we are using a Grove's, Daniel's, or Smees' cup, the size of cup gives quantity. Multiplying the cups gives intensity, though the quantity is not increased. The use of Ruhmkorff's coil, or helix with an apparatus for breaking the current, also gives intensity. Intensity from increasing the number of the cups,

gives a constant current, and is called galvanism by recent writers. The broken current intensified by the helix—induction currents—is called Faradization.

76. Both the constant and broken currents are employed in medicine, and there are certainly cases where the one is decidedly preferable to the other. But as the broken current is more easily used, the apparatus cheaper and more portable, and with far less danger of doing harm, it is the one to be recommended to the general practitioner.

77. Referring to Ganot's Physics we find the following statements, which may be taken as a basis for the use of electricity in medicine:

"In fact, since induction currents, although very intense, have a very feeble chemical action, it follows that when they traverse the organs, they do not produce the chemical effects of the current of the battery, and hence do not tend to produce the disorganization. Further, in electrifying the muscles of the face, induction currents are to be preferred, for Dr. Duchenne has found that these currents only act feebly on the retina, while the currents of the battery act energetically on the organ, and may affect it dangerously, as serious accidents have shown. There is a difference in the action of induced currents of different orders; for while the primary induced current causes lively muscular actions, but has little action on the cutaneous sensibility, the secondary induced current, on the contrary, increases the cutaneous sensibility to such a point, that its use ought to be proscribed to persons whose skin is very irritable.

"Hence electrical currents should not be applied in therapeutics without a thorough knowledge of their various properties. They ought to be used with great prudence, for their continued action may produce serious accidents. Matteucci, in his lectures on the physical phenomena of living bodies, expresses himself as follows: 'In commencing, a feeble current must always be used. This precaution now seems to me the more important, as I did not think it so before seeing a paralytic person seized with almost tetanic convulsions under the action of a current formed of a

single element. Take care not to continue the application too long, especially if the current is energetic. Rather apply a frequently interrupted current than a continuous one, especially if it be strong; but after twenty or thirty shocks at most, let the patient take a few moments' rest.'"

78. In selecting an apparatus for the use of electricity in medicine, we will take that which, giving the largest plates, is most easily kept clean, is most portable, has the best inductive coils, and the best rheotome, or current-break. The talk about two, four, six, eight, or a dozen currents amounts to but little, as any number of currents may be given by increasing the separate coils of wire in the helix. If there are two layers of wire we have two currents; if three, three currents, etc., each induced current running in opposite direction to the primary. As I judge, the only difference in a six-current battery is, that the currents are of different intensity, and run in opposite directions. The primary current is the one derived from the elements, the others are induced currents.

79. With regard to the *poles*, the positive is from the copper, the negative is to the zinc. The direction of the current is from the copper to the zinc, and if a portion of the body be made a part of such conductor, the electricity will pass through it from the positive to the negative pole.

80. It has been claimed that the current passed in the direction of the nerves was stimulant and tonic; that passed in the opposite direction, it was contra-stimulant or sedative. Whilst there is a small amount of truth in this statement, and it may be made use of in the treatment of some affections, its importance is overrated. The fact is, the nerves do not serve as conductors in most cases. The electric current never takes a circuitous route, if it can go directly. If the nerves run directly from pole to pole, and are sufficiently superficial, the current may take nerves in preference; if other tissue furnishes the most direct route, it will serve as the conductor.

81. It may be said that those cases in which a stimulant and tonic influence is indicated, are the ones especially benefited

by the judicious use of electricity. In those cases in which there is increased irritability, *plus* animal electricity, it should be used with great care, and only after the operator has practical experience and skill.

82. The first and most important use of electricity is its general application in the following way. The patient should be loosely clothed in flannel, so that the hand can readily reach all parts of the body, at the same time it is protected from chill. We then wet a soft sponge in hot water, wringing it dry, and wrapping the *negative* pole in it, place it at the coccyx, or under one or both feet. Now wrap the positive *pole* in a second wetted sponge and pass it over the entire surface of the body, as if giving an ordinary sponge-bath. Recollect the advice of the quotation from Ganot, use the current of that strength which is most agreeable to the patient, increasing the intensity as the patient can bear it. It is in fact an electrical sponge bath, and should leave the patient invigorated, not depressed.

83. In many cases marked soreness of parts will follow the use of electricity, and I think it may be taken for granted that it has been used too strong, or the application was too prolonged. The common opinion of those who make electricity a specialty is, that diseased parts must be "awakened," and that this awakening is indicated by soreness afterwards and by pain during the application—this is a mistake.

84. The *quantity* depends wholly upon the size of the elements (plates), and the larger the plates the greater the quantity, the smaller the plates the less the quantity. When you are invited to buy a baby-battery, or a pocket instrument, with the endorsement that it is *just* as strong, you will know that strength means intensity, not quantity. A strong solution, and consequently increased chemical action, increases the quantity; a weak solution and feeble chemical action diminishes the quantity.

85. It don't make any difference whether the current is generated by dilute muriatic acid, a solution of sulphate of copper, or mercury, so far as its medicinal value is concerned; the dif-

ference being in the ease with which batteries are kept clean and in good working order.

86. For the ordinary purpose in electro-therapeutics a battery with single cup and plates of moderate size, with an inductive coil—helix—to increase the intensity, is the best. For the purposes of the galvano-cautery, from four to six *large* cups are required, using the constant current.

87. Electricity may be employed as a vital stimulant, or as a sedative, the first being its most important use. If the current is passed in the direction of the nervous current, from the brain or spinal cord outwards, the application is stimulant. If the current is passed in the opposite direction it is sedative. To get the stimulant effect the *positive* pole is applied to the spine, and the *negative* is passed over the organ or part affected. To produce sedation the *negative* pole is applied to the spine, and the *positive* pole is applied to or passed over the part affected.

88. The action that we want in most cases, is that moderate stimulation, which improves the innervation, circulation, nutrition and waste, and functional activity of a part, and which by repetition leads to a real "renewal of life."

89. The general use of electricity is by far its most important one, and should generally form the major part of the treatment. As before named, it is really an electrical sponge bath, one pole being stationary, the other enveloped in sponge passed over the entire surface of the body. Every writer on electricity concedes the utility and importance of this treatment, and the majority insist upon it as an essential part even in the treatment of local diseases. Speaking from my own experience, it has given most excellent results in many cases, and I have experienced the benefits in my own person.

90. With regard to local treatment, there is not so much uniformity in opinions, yet they agree in the main—that the diseased part should have a *longer* dose. For instance, if the stomach or liver, or bowels, or lungs, or a group of muscles, are specially affected, in addition to the general use, the current should be passed through these parts for a longer time.

91. Physicians seem to be at a loss for instruments to make the application when wanted. If a case of Kidder's or Hall's handles or electrodes are purchased, they will serve almost all purposes. If not, bear in mind that the major use and benefit can be had by simply wrapping the terminal copper wire or the ordinary handles in sponge. Insulation of a wire, a handle, uterine or vesical instrument, is easily effected by means of rubber tubing. If you want a uterine instrument, take a piece of small rubber tube fourteen inches long, pass a copper or even iron wire through it, bend it upon itself at one end to hold the sponge, at the other to connect with the insulated wire from the battery, and you have it. If you want a vaginal instrument, a rectal instrument, one for the tongue, or any part of the body, and you can not get it from the city, have the nearest tinner make you what you want, and solder on a loop of copper wire for an attachment.

92. To get a rational idea of the best methods of local treatment, I would advise a re-study of anatomy rather than common works on electrical medication. If we want to medicate an organ, we want to know the best means of getting our remedy to it; if it do n't reach it, it will surely not do it any good. It is all nonsense to talk of influencing the abdominal viscera by placing one pole under the feet, and rubbing the other over the abdomen, or even placing one at the coccyx and passing the other over the abdomen. Every tissue is a conductor, and we do not know that the nerves are much better conductors than muscle or skin. If you place the poles of the battery in such position that the shortest way from one to the other is through an organ, then you will reach it. If you wish to stimulate the nervous supply of an organ, you place your poles in such position that the current will run in the course of the nerves.

93. If, therefore, you wish to reach the stomach, the current would run from the upper dorsal spine behind to the epigastrium in front; or, if the spleen, liver, or upper intestinal canal were to be medicated, the one sponge would be passed over these. Why? Because the great splanchnic has its origin, course, and

termination in this way. If you want to reach the kidneys, or parts supplied from the renal plexus, the one sponge would be passed up and down the lower dorsal spine, the other over the kidneys, bladder, or testicles, as we wished to treat these organs. If we wanted to treat the uterus, the current might be passed through the uterine globe from the one pole on the abdomen, the other through a uterine handle, to the cervix uteri; or from the lumbar spine to the uterus and over the hypogastric region.

94. Here, as in other things, if the physician will sit down and think the matter out for himself, he will probably have better success. No man can practice medicine automatically with success. True, we have had an automaton chess player, who did tolerably well with a man inside of him, as we have had thousands of automaton physicians who would have been vastly improved by a man inside of them. If I had but one parting word of advice, it would be—do your own thinking, if you don't do any thing else.

CHAPTER II.

CELLULAR PATHOLOGY.

95. I adopt the heading of this chapter more because it is the fashion to speak of cellular pathology than for its real meaning. What I intend to consider is, the methods of deve'opment, and what laws underlie the formation and action of the ultimate elements of the tissues.

96. It will be observed that in almost every chapter we will have to consider many of the same effects from very different stand-points; and it will be our object to prove that they point to the same definite pathological and therapeutical laws; that whether we reason from *humoralistic* doctrines, or from the *nervous, soladistic*, or *cellular*, we arrive at the same results. While a perfect theory of disease can not be formed from observations on the solids, fluids, or nervous system, we may approximate toward it by an examination of the whole. The error of modern pathologists has been the attempt to account for phenomena by an analysis of but one of a series of causes.

97. Rudolf Virchow is the father of cellular pathology, looking to it for an explanation of all the processes of disease, claiming that as all life is from cells, healthy life is from healthy cells, and diseased life from diseased cells. That we may have a better appreciation of what is claimed for it, I will make a quotation from his work:—

"If we consider the extraordinary influence which Bichat in his time exercised upon the state of medical opinion, it is indeed astonishing that such a relatively long period should have elapsed

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termed the *formative*, and which effects its organization, gives it functional activity during its life, and transmits the same vitality to its successors. In regard to cells we recognize the following facts:

99. There is *no spontaneous generation of cells*, but their origin is directly traceable to a parent cell. This law of cell-growth is absolute so far as our observation extends, and embraces all changes of structure and growth in the human body.

100. That the formative power acting from the Supreme Being, by methods beyond our reason, groups the offspring of the original or parent cell to form tissues and organs of different forms and for different purposes.

101. That in this grouping the cells have—first, the power of increase to the standard size of the organ or part; second, the power of reproduction to supply the continued waste; and, third, a power of resistance to external agencies by which they live an appointed time.

102. They have also a power of changing material and arranging it in different forms, and that not only within their walls, but for a certain distance around them. Though every growth is a cell-growth, and without a cell there is no organic form, we recognize the adaptation of plastic material beyond the cell-wall, and yet under its influence.

103. Need I say here that every function of life has its origin in these microscopic forms; it would not be possible to draw any other inference. In the same manner we claim that each of these forms has an inherent and individual life, and that the association of this life is the sum of the life of man.

104. From these propositions we cannot but see that health and life flow from their perfect formation, and that disease and death will follow changes from this. If, therefore, we can unravel the laws of cell-growth, cell life, and cell activity, we will have accomplished much toward a rational system of medicine.

105. I view these laws as simple. They are —first, an original viability; second, a supply of nutrient material properly formed for their use; third, circumstances fovorable for develop-

ment. It will be noticed that these are as applicable to the entire body as to each individual cell, and that they are readily appreciated and acted upon.

106. We do not study human histology and develop from it the history of the ultimate elements of our bodies, that we may continually regard them as microscopic objects, and examine them as such; but that in this manner, having observed the forces and determined the laws of the cell, we may apply this knowledge to the sum of the forces and of the body; for it is a well-established law that what is true of a part must be true of the whole.

107. Illustrative of the above propositions, let me briefly call attention to the development of the human being. The human egg, from which we trace this growth, is a cell from the ovary of the mother, and is thus legitimate in origin, according to our proposition (99.) This egg contains a *germinal* cell, which has a nucleus, the *germinal spot*. The first act of growth is the division of the nucleus in two, soon followed by the complete division of the cell in two, having the same form as the original one. There is next a division of these two into four, and then of these into eight, until, in the course of a few days, the entire plastic material of the egg has been worked up into cells, which have arranged themselves to form a membrane. This germinal membrane seperates into two layers, an external or serous, and an internal or mucous; and subsequently another is formed between them, called the vascular layer. The serous layer gives origin to the skeleton, brain, and spinal marrow, the mucous layer to the heart and vascular system.

108. We may find, even in this early period, deviations from the normal type of development, giving rise to monstrosities, or more frequently to but slight lesions of structure—deformities and mother's marks. We should not expect to find these of frequent occurrence, as the conditions of development can with difficulty be reached by any cause of disturbance. Still, in their occasional disturbance, we may learn our first lesson of diseased development, and from this weigh the importance of a

knowledge of cellular physiology and pathology in the science of medicine.

109. The three conditions are imperative in fœtal development, and many times we may directly trace the error or the arrest of fœtal life to their violation. Habitual abortion, from constitutional syphilis on the part of either parent, is an example of the first. Abortion and defective development is not unfrequent from deficiency of nutrient material, either from disease affecting the digestive organs of the mother, or the placenta through which the child received its supply; while in many instances of fœtal death or defective development we can distinctly trace an error in the third proposition.

110. These conditions are as necessary to the entire organism as to the individual cell, otherwise we would not be benefited by knowing them. We have constant cognizance of the gross form, while the minute structure is beyond our vision, only as we bring the microscope to bear upon it. Let us now see how they are applicable to the body as a whole.

111. *First.*—An original viability is seen to be an imperative condition. A want of this gives us herditary diseases and early death. A want of it also gives us an enfeebled life and a want of resisting power to the ordinary causes of disease: whilst a strong viability gives great resisting power to disease, and long life. This has already had a partial consideration (16).

112. *Second.*—A proper supply of nutrient material is also an absolute condition, as man only lives by a constant renewal of his body. The material for this renewal being furnished, and the cells possessing a normal formative power, life continues in a regular manner.

113. *Third.*—The circumstances favorable for normal development in man are a normal circulation, innervation, temperature, and excretion (18).

114. When we study the life of a cell, we find it dividing itself into four parts, each of which deserves consideration. It is born, grows to the size of a cell, does the work of a cell, gives birth to its kind and dies. This life occupies a variable period

of from three to eight months, the average healthy life bei about four months. If the reader will think for a moment will see that this is also the life of a man—he is born, grows the stature of a man, does the work of a man, propagates l species, and gets out of the world to make a place for his su cessor.

115. A very great deal depends upon the parentage of cel for only healthy cells can give birth to healthy cells. In mar cases feebleness of tissue propagates itself for months and yea and there can be no restoration to health except by the repeat renewals of life under better conditions—each tissue having be ter cells for parents, we have better cells as children.

116. Necessarily we must have good material for the buildi or growth of cells, for if the material is in any respect imperfec the cell must share this imperfection. Thus in renewing tl life of tissue it is essential that our patients shall have good foo well prepared, well digested, containing such material as is nece sary for the formation of all parts, good blood-making, a goo circulation, right temperature, and right innervation.

117. All parts of the body and all tissues are made for us and without this legitimate use they can not be healthy, and ca not be the parents of good tissue. The lazy tissue begets a laz imperfect tissue; the active tissue begets an active, healthy tissu In some cases of disease the success of treatment will deper upon right exercise, more than upon the administration of drug Gradually the organ or part, or the whole man, is brought bac to normal use or work, and gradually it is strengthened for i and its life improved. I wish to place stress on the word *gradu* for in most cases sudden, prolonged, or over exercise does injur

118. Healthy active tissues or cells beget their kind, and tl new cells are woven in the place of their parents, and proceed do their work, as the old cells fall out and are taken up and ca ried away in the current of the blood. Further on we will stu the waste of tissue, and will find it just as important to healtl [illegible]

119. Animal cells may be divided into three varieties—*formative, secreting,* and *necrological.* The first withdraw from the blood the material for the formation of tissue; and with this are arranged in and form a part of the tissues of the body. The second are developed in secreting structure; and, having withdrawn the material of the secretion from the blood, they are cast off with this into the common excretory duct. The third are formed during retrograde metamorphosis in certain cases, and evidence the control of vital power, even in the death of a part.

120. Formative cells are normally developed in the exact situation of the same material, and in the exact form of the parent cells from which they had their origin. Thus a part perfectly reproduces itself in size, form, and function, as the old material is worn out, dies, and is removed. Muscular tissue always produces *muscular cells,* as is the case with fibrous, nervous, and osseous tissue.

121. Secreting cells are likewise developed with the same form and the same affinities for certain material in the blood, which is removed for secretion. We have no means of knowing why a cell in the liver removes bile; in the stomach, gastric juice; in the salivary glands, saliva; and we account for it by the well-known law that a cell in health always has the form and function of its parent; and we leave the origin of such function with the Creator, who has so wonderfully adapted the animal mechanism to the various circumstances of life.

122. Necrological cells have their parentage in formative cells, and seem to be destined to govern the process of retrograde metamorphosis in certain cases, so that the vitality of the whole body may not be impaired. Pus cells are the type of this formation, if not the only example.

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since Schwann made his great discoveries, without the real importance of the new facts having been fully appreciated. This has certainly been essentially due to the great incompleteness of our knowledge with regard to the intimate structure of our tissues, which has continued to exist until quite recently, and, as we are sorry to be obliged to confess, still even now prevails with regard to many points of histology to such a degree that we scarcely know in favor of what view to decide.

"Especial difficulty has been found in answering the question, from what parts of the body action really proceeds—what parts are active, what passive; and yet it is already quite possible to come to a definite conclusion upon this point, even in the case of parts the structure of which is still disputed. The chief point in this application of histology to pathology is to obtain a recognition of the fact that the cell is really the ultimate morphological element in which there is any manifestation of life, and that we must not transfer the seat of real action to any point beyond the cell. Before you I shall have no particular reason to justify myself if in this respect I make quite a special reservation in favor of life. In the course of these lectures you will be able to convince yourselves that it is almost impossible for any one to entertain more mechanical ideas in particular instances than I am wont to do, when called upon to interpret the individual processes of life. But I think that we must look upon this as certain, that however much of the more delicate interchange of matter which takes place within a cell may not concern the material structure as a whole, yet the real action does proceed from the structure as such, and that the living element only maintains its activity as long as it really presents itself to us as an independent whole.—*Cellular pathology*, page 29.

98. *The Ultimate Organic Form.*—All organic life, whether vegetable or animal, has one typical form, that in its essence is never changed. This form is that of a *cell*, usually microscopic, but always composed of a cell-wall, cell contents, and mostly a nucleus. It is this structure which has that special force which we have

termed the *formative*, and which effects its organization, gives it functional activity during its life, and transmits the same vitality to its successors. In regard to cells we recognize the following facts:

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108. We may find, even in this early period, deviations from the normal type of development, giving rise to monstrosities, or more frequently to but slight lesions of structure—deformities and mother's marks. We should not expect to find these of frequent occurence, as the conditions of development can with difficulty be reached by any cause of disturbance. Still, in their occasional disturbance, we may learn our first lesson of diseased development, and from this weigh the importance of a

knowledge of cellular physiology and pathology in the science of medicine.

109. The three conditions are imperative in fœtal development, and many times we may directly trace the error or the arrest of fœtal life to their violation. Habitual abortion, from constitutional syphilis on the part of either parent, is an example of the first. Abortion and defective development is not unfrequent from deficiency of nutrient material, either from disease affecting the digestive organs of the mother, or the placenta through which the child received its supply; while in many instances of fœtal death or defective development we can distinctly trace an error in the third proposition.

110. These conditions are as necessary to the entire organism as to the individual cell, otherwise we would not be benefited by knowing them. We have constant cognizance of the gross form, while the minute structure is beyond our vision, only as we bring the microscope to bear upon it. Let us now see how they are applicable to the body as a whole.

111. *First.*—An original viability is seen to be an imperative condition. A want of this gives us herditary diseases and early death. A want of it also gives us an enfeebled life and a want of resisting power to the ordinary causes of disease: whilst a strong viability gives great resisting power to disease, and long life. This has already had a partial consideration (16).

112. *Second.*—A proper supply of nutrient material is also an absolute condition, as man only lives by a constant renewal of his body. The material for this renewal being furnished, and the cells possessing a normal formative power, life continues in a regular manner.

113. *Third.*—The circumstances favorable for normal development in man are a normal circulation, innervation, temperature, and excretion (18).

114. When we study the life of a cell, we find it dividing itself into four parts, each of which deserves consideration. It is born, grows to the size of a cell, does the work of a cell, gives birth to its kind and dies. This life occupies a variable period

of from three to eight months, the average healthy life being about four months. If the reader will think for a moment he will see that this is also the life of a man—he is born, grows to the stature of a man, does the work of a man, propagates his species, and gets out of the world to make a place for his successor.

115. A very great deal depends upon the parentage of cells, for only healthy cells can give birth to healthy cells. In many cases feebleness of tissue propagates itself for months and years, and there can be no restoration to health except by the repeated renewals of life under better conditions—each tissue having better cells for parents, we have better cells as children.

116. Necessarily we must have good material for the building or growth of cells, for if the material is in any respect imperfect, the cell must share this imperfection. Thus in renewing the life of tissue it is essential that our patients shall have good food, well prepared, well digested, containing such material as is necessary for the formation of all parts, good blood-making, a good circulation, right temperature, and right innervation.

117. All parts of the body and all tissues are made for use, and without this legitimate use they can not be healthy, and can not be the parents of good tissue. The lazy tissue begets a lazy, imperfect tissue; the active tissue begets an active, healthy tissue. In some cases of disease the success of treatment will depend upon right exercise, more than upon the administration of drugs. Gradually the organ or part, or the whole man, is brought back to normal use or work, and gradually it is strengthened for it, and its life improved. I wish to place stress on the word *gradual*, for in most cases sudden, prolonged, or over exercise does injury.

118. Healthy active tissues or cells beget their kind, and the new cells are woven in the place of their parents, and proceed to do their work, as the old cells fall out and are taken up and carried away in the current of the blood. Further on we will study the waste of tissue, and will find it just as important to healthy life as its renewal.

119. Animal cells may be divided into three varieties—*formative, secreting,* and *necrological.* The first withdraw from the blood the material for the formation of tissue; and with this are arranged in and form a part of the tissues of the body. The second are developed in secreting structure; and, having withdrawn the material of the secretion from the blood, they are cast off with this into the common excretory duct. The third are formed during retrograde metamorphosis in certain cases, and evidence the control of vital power, even in the death of a part.

120. Formative cells are normally developed in the exact situation of the same material, and in the exact form of the parent cells from which they had their origin. Thus a part perfectly reproduces itself in size, form, and function, as the old material is worn out, dies, and is removed. Muscular tissue always produces *muscular cells,* as is the case with fibrous, nervous, and osseous tissue.

121. Secreting cells are likewise developed with the same form and the same affinities for certain material in the blood, which is removed for secretion. We have no means of knowing why a cell in the liver removes bile; in the stomach, gastric juice; in the salivary glands, saliva; and we account for it by the well-known law that a cell in health always has the form and function of its parent; and we leave the origin of such function with the Creator, who has so wonderfully adapted the animal mechanism to the various circumstances of life.

122. Necrological cells have their parentage in formative cells, and seem to be destined to govern the process of retrograde metamorphosis in certain cases, so that the vitality of the whole body may not be impaired. Pus cells are the type of this formation, if not the only example.

CHAPTER III.

NUTRITION OF TEXTURE.

So closely are our subjects interwoven that they are with difficulty separated so as to give each one the consideration that it demands, without continued repetition. But, as heretofore remarked, we find in each the same underlying general laws, so that the result arrived at is the same from whatever point we examine it.

FOOD.

123. In studying the processes of nutrition, we will have first to examine the materials employed, and the methods by which they are fitted for use, according to propositions in (112). The requirement in this regard for healthy nutrition may be plainly stated—that the food be of good quality, properly prepared, well digested, and that it be carried to the parts requiring it. This statement seems so plain that it hardly needs any elaboration, and yet we find gross violations of it with both the people and their medical guardians.

124. Food is divided into two kinds, *histogenetic* or tissue-making, and *calorifacient* or heat-producing. Of the first, there is necessary in the adult, that amount which will compensate for the daily waste of tissue. Of the second, the amount necessary to

maintain the temperature at 98°. If there is an increase of the first, and the formative forces are active, we find an increase in the tissues, especially the muscular; this increase, however, is to a limited extent, and is dependent almost wholly upon the activity of the organ. If there is an increase in the second, and it is appropriated by the body, it is stored up as adipose tissue.

125. If the histogenetic food is *deficient*, we will observe loss of activity in parts, loss of size, and loss of strength. We are to especially regard those functional lesions that flow from this, as they form some of the most prominent of the phenomena of disease. Of these I need but name generally debility, defective innervation, defective circulation, and defective secretion. If the calorifacient food is deficient, we find that the adipose tissues of the body are first drawn upon, then the histogenetic food is burned, and finally, that the nitrogenized tissues are also used as fuel. So long as the person lives, the standard of heat must be maintained, and to this end all combustible matter will have to aid.

126. This is frequently noticed in both acute and chronic disease, and seems sometimes to be the principal source of danger. When from disease it is impossible to introduce into the system a full supply of both kinds of food, we see the histogenetic material continuously used as fuel, thus impoverishing the tissues, and preventing that return of strength which would also give better digestion. It is in these cases that we modify the process of combustion, or give cod-liver oil or other combustible material that will supply the demand. This point has been already referred to (47). It may be interesting to the reader to know what parts suffer most during deprivation of food, and it may also prove of some particular value. Tnis has been determined by some experiments of M. Chossat in the warm-blooded animal:

Parts which lose more than 40 per cent.		Parts which lose less than 40 per cent.	
Fat	93.3	Muscular coat of stomach	39.7
Blood	75.0	Pharynx and oesophagus	34.2
Spleen	71.4	Skin	33.3
Pancreas	64.1	Kidneys	31.9
Liver	62.0	Respiratory apparatus	22.2
Heart	44.8	Osseous system	16.7
Intestines	42.4	Eyes	10.0
Muscles of locomotion	42.3	Nervous system	1.9

127. Occasionally lesions arise from *perversion* of the food, and are best remedied by correction of this. As marked examples of this, we have those wide-spread and serious diseases which in Northern Europe have periodically followed the use of defective grain, and in Ireland the potato disease. We need not go so far, however, as our own cities furnish us with abundant examples of disease from this source, and during the rebellion it was quite frequently met with in our armies. With the poorer classes it is sometimes so marked that we need but to give a sound and easily-digested food to ensure recovery.

128. But we have instances among the rich and well provided that deserve notice. Frequently the milk of the nursing mother, especially after the first twelve months, comes under this classification, and numerous infantile diseases flow from it. In some instances the continued use of *very finely-ground and bolted* flour is also a cause of imperfect nutrition, especially, as in the case of some children, when they have no taste for animal food, but have its place supplied with saccharine elements.

129. This brings up another and very important matter in the selection of food. It must posses a sufficient amount of certain inorganic elements, and without these there must be feebleness and at length disease. These materials are furnished in natural food, and we are deprived of them by its artificial preparation. The principal of these are lime, soda, potash, phosphorus, iron, and sulphur. When we have reason to believe that any one or more of these are deficient, a correct treatment will supply the missing elements in that form in which they will be most readily appropriated.

130. There are some facts in connection with this subject that we may so group together that their bearing will be seen at a

glance, and they can be readily utilized. And first, we have a table, of the diurnal ingesta, secretions, and excretions of a man, from Draper's Physiology.

PHYSIOLOGICAL STANDARD TABLES.

	Diurnal Ingesta, Secretions and Excretions of a man whose weight is 140 lbs. avoird's.	
	Weight of body	140.000
Ingesta.	Water	4.109
	Oxygen	2.192
	Dry vegetable food	1.687
	Dry animal food	.563
Secretions and Excretions.	Saliva	3.300
	Gastric juice	14.080
	Pancreatic juice	.440
	Bile	3.500
	Carbon from lungs	.500
	Intestinal juice	.440
	Loss water by lungs	1.440
	" " skin	2.234
	Fæces	.078
	Urine	2.180
	Consisting of—	
	Water	2.034
	Urea	0.65
	Uric acid	.002
	Lactic acid	.037
	Sulphuric acid	.007
	Phosphoric acid	.008
	Chloride of sodium	.009
	Alkalies and earth	.016
	Other bodies	.002
In the Circulation	Blood	17.000
	Consisting of—	
	Water	13.328
	Albumen	1.190
	Fibrin	.037
	Discs	2.227
	Fats	.022
	Chloride of sodium	.061
	Chloride of potass	.006
	Phosphate of soda	.003
	Carbonate of soda	.012
	Sulphate of soda	.004
	Phosph. lime and mag.	.004
	Oxide and phos. iron	.008
	Other bodies	.098

In this table the estimate is in the avoirdupois lb. and decimals thereof.

	Diurnal Ingesta, Secretions, and Excretions of a man whose weight is 1,000 parts.	
	Weight of body	1000.000
Ingesta.	Water	29.350
	Oxygen	15.657
	Dry vegetable food	12.050
	Dry animal food	4.021
Secretions and Excretions.	Saliva	23.576
	Gastric juice	100.571
	Pancreatic juice	3.143
	Bile	25.000
	Carbon from lungs	3.571
	Intestinal juice	3.143
	Loss water by lungs	10.286
	" " skin	15.957
	Fæces	.557
	Urine	15.571
	Consisting of—	
	Water	14.529
	Urea	.464
	Uric acid	.014
	Lactic acid	.264
	Sulphuric acid	.050
	Phosphoric acid	.057
	Chloride of sodium	.064
	Alkalies and earths	.114
	Other bodies	.014
In the Circulation.	Blood	121.429
	Consisting of—	
	Water	95.200
	Albumen	8.500
	Fibrin	.264
	Discs	15.907
	Fats	.157
	Chloride of sodium	.436
	Chloride of potass	.043
	Phosphate of soda	.021
	Carbonate of soda	.086
	Sulphate of soda	.029
	Phosph. lime and mag.	.029
	Oxide and phos. iron	.057
	Other bodies	.700

In this table the estimate is upon one thousand parts.

131. The difference between foods may usually be readily determined, if we recollect that *histogenetic*, or blood and tissue-making food, contains nitrogen, while the *calorifacient*, or heat-producing, does not contain this element. We must not forget, however, that the most of our food is *mixed*, containing both of

these. We may usually determine their value in either respect, if we compare them with this table:—

ELEMENTS OF NUTRITION—HISTOGENETIC.

Vegetable fibrin.	Animal flesh.
Vegetable albumen.	Animal blood.
Vegetable casein.	

ELEMENTS FOR THE PRODUCTION OF HEAT—CALORIFACIENT.

Fat.	Cane sugar.
Starch.	Grape sugar.
Gum.	Sugar of milk.
Pectin.	Alcohol.

132. A food is valuable as it possesses both of these in a form easily made use of by the body. Facility of comminution and digestion being the next most important point in its consideration. But in disease it sometimes becomes necessary to choose the food with reference to the proportions of one or the other, as we may be desirous of increasing the formation of tissue, or of furnishing the material for the production of heat. The following table, from Dr. Carpenter, shows the amount of nitrogen in some of the more common articles of food, and hence their value as *tissue* producers:—

VEGETABLE.

Rice	81	Oats	138	Peas	239
Potatoes	84	White bread	142	Agaricus russula	264
Turnips	106	Wheat	119..144	Lentils	276
Rye	106	Carrots	150	Haricot beans	283
Maize	100–125	Brown bread	165	Agaricus deliciosus	289
Barley	125	Agaricus cantharellus	201	Beans	320

ANIMAL.

Human milk	100	Salmon, raw	776	Flounder, raw	898
Cow's milk	237	" boiled	610	" boiled	954
Oyster	305	Liver of pigeon	742	Pigeon, raw	756
Yolk of eggs	305	Portable soup	764	" boiled	827
Cheese	331–447	White of egg	845	Lamb, raw	833
Eel, raw	434	Crab, boiled	859	Mutton, raw	773
" boiled	428	Skate, raw	859	" boiled	852
Liver of crab	471	" boiled	956	Veal, raw	873
Mussel, raw	528	Herring, raw	916	" boiled	911
" boiled	660	" boiled	808	Beef, raw	880
Ox liver, raw	570	" milt of	924	" boiled	942
Pork ham, raw	539	Haddock, raw	920	Ox lung	931
" boiled	807	" boilded	816		

133. In concluding this subject I may advantageously quote the conclusions the same author arrives at with regard to food:

"1. That a due adjustment of the albuminous, oleaginous, and saccharine constituents of the food, to the varying conditions under which man exist, is of the first importance; and that the questions of the derivation of the first two of these constituents from the animal or from the vegetable kingdom is one of secondary character; each being capable of yielding them in adequate amount, and the only condition requisite being, that the articles of food shall be so selected as to supply the needful quantity.

"2. Experience teaches, however, that it is not a matter of entire indifference whether the albuminious constituent be drawn from the animal or from the vegetable kingdom; for the use of a highly-animalized diet has a tendency to *raise*, and that of a vegetable diet to *lower*, the proportion of red-corpuscles in the blood; while, by a due adjustment of the proportion of the two classes of components, the evil effects of the exclusive use of either may be prevented.

"3. So, again, experience teaches what could scarcely have been anticipated theoretically; namely, that, notwithstanding the power which the living body possesses of converting saccharine compounds into oleaginous, the ingestion of a certain amount of oleaginous matter *as such* is necessary, or at least is favorable to the maintenance of health.

"4. Another of the results of experience, of which science has not yet given a definite *rationale*, is the necessity of employing *fresh vegetables* as an article of diet; the almost invariable consequence of the entire omission of them being the development of that peculiar constitutional disorder which is known as *scurvy*.

"5. Finally, then, a well arranged dietetic scheme ought to consist of such a combination of the albuminous, oleaginous, and farinaceous constituents, as is most appropriate to the requirements of the system; a larger measure of the *albuminous* being supplied when an unusual amount of nervo-muscular exertion is put forth, and this supply being then most advantage-

ously derived from animal flesh; a larger measure of the *oleaginous* being required for the sustentation of the heat in a frigid atmosphere, and this being supplied equally well by the vegetable kingdom as by the animal; and a larger proportion of the *farinaceous*, as a substitute for the oleaginous, being most favorable to health under a high atmospheric temperature."

PREPARATION OF FOOD.

134. In order that food shall serve its purpose properly, it is necessary that it be well prepared for use. It is true some articles, as fruits and nuts, may be used as furnished by nature, but the larger number and more essential articles, are prepared by cooking. Good cooking is essential to good digestion and good blood-making; not that a person may not live upon badly cooked food for a long time, and the digestive organs may even grow able to dispose of badly prepared food for three-score years and ten. But with the majority of persons the digestive organs will after a time fail, and in these cases a cure will depend upon a right preparation of food. In other cases these organs are enfeebled by disease, and a careful preparation of food becomes essential to nutrition.

135. The application of heat in cooking is principally to break up the cell forms of the food, or to macerate, solve, or render friable the connective tissue, so that it may be more readily broken up by the organs of digestion. It is true that it is rendered more palatable, and sometimes seems to be changed by cooking; but it is more palatable because the juices and real food are set free, and such changes as have taken place are in the direction of fitting the materials for use in the body, as when starch is changed into grape sugar.

136. There are two objects, then, in the preparation of food, both important: one to put it in better condition for the action of the digestive organs, the other to render it more palatable. The first purpose may be served by a process of cooking which will render the food objectionable or repulsive; and the second being the principal object, the food, though pleasant to the taste,

will be indigestible. I think there is no reason why food may not be so cooked as to be easily digested and at the same time palatable.

137. Foods may be cooked with water, with steam, or with dry heat, and cooked equally well, so as to be digestible and palatatable. They are also cooked so as to give the food in fluid form, or in substance, as may be desired or needed.

138. In cooking with water it is to be remarked, that if the substance of the food is to be extracted by the fluid, the process must be commenced with cold water, the heat gradually applied, the process slow, and the temperature should not be raised to the boiling point. In making a meat soup, the meat is placed in cold water, gradually heated, and a low temperature maintained for three or four hours or longer. In making a vegetable soup, the same process is followed, but less time is required. In making a beef-tea for a sick person, the finely chopped lean of beef is put in a sauce-pan and covered with cold water, and heat gradually applied. Salt and condiments should be added when the cooking is nearly complete.

139. If it is desired to retain the substance of the food in it, the cooking is commenced with hot water, and the heat rapidly raised at first, or by just sufficient water to raise a steam. In this way there is a rapid coagulation of albuminoid substances at the surface, and the nutrient materials are retained. Thus if we wish to boil a piece of meat, we heat the vessel and the water, and putting the meat in, pour on a small portion of water first, which is rapidly heated and forms steam; then water is added to cover the meat, and the vessel is closely covered. The same rules must be observed in cooking vegetables.

140. We frequently find housekeepers wholly inattentive to these simple principles. A nice piece of meat is put in cold water, and the substance is thoroughly cooked out of it and thrown away, whilst the tough, tasteless rag of beef is served on the table. Vegetables are frequently spoiled in the same way—the tasteless shell coming to the table, and the nutrient material going into the slop-barrel. Much difficulty is experienced in

having proper food for the sick, even where the common articles of food for the well are reasonably prepared, and physicians should know the principles of good cooking, and should be able to teach the community.

141. Cooking by steam is an excellent and economical method where large quantities of food are to be prepared, and with some modern improvements in the furniture of stoves, may well be employed by small families. Here, also, we have to think whether it is the slow, solvent action of the vapor of water, that is wanted to soften and break up the connective tissue, or the rapid application of super-heated steam to coagulate the albumen of the surface, so that the juices may be better retained. Very tough meat may be cooked tender by steam, and at the same time be palatable, and we are not all obliged to buy the finer pieces of meat in order to have a good dinner. Vegetables are nicely cooked by steam, but in order to succeed well, an active fire must be maintained, otherwise they will absorb water and become sodden and tasteless.

142. The application of dry heat in roasting or baking is an excellent method of cooking. In the olden time meats were roasted before an open fire on a spit, the surface being "basted" with some preparation, as of butter and flour, which, forming a crust, would retain the juices. Meats are still broiled by those who understand cooking, and the result is most palatable and digestible food. It is a little singular that so simple a process in cooking should be neglected, and meats rendered unsavory and indigestible by frying. Where wood is burned, the old-fashioned gridiron is the best cooking utensil, and meats broiled over the coals can not be improved.

143. To roast meat well, it is necessary that a quick heat be applied at first, as by a super-heated steam, or that the roast be "basted" so as to retain the juices. After this the temperature need not be so high, time being the principal element in thorough cooking.

144. As our country advances in civilization, and the population becomes more dense, greater attention must needs be given

to the preparation of food. We have been a very wasteful people, and economy will now be necessary, and we have had an immense amount of poor cooking that could only be borne by persons accustomed to active out-door exercise. We must learn a lesson from European peoples, and utilize every thing in the shape of food; and we will also do well to learn from them how to cook it so that it will be palatable and digestible. Among the lessons we will learn is, that fluid food (soup) is economical and healthful, and that there is nothing in the shape of food that can not be utilized in its preparation.

145. "Bread is the staff of life," and we will not forget that good bread is an essential of good living and of good health. As a people we are accustomed to miserable bread, ranging from yellow "saleratus biscuit" to the sour or sodden loaf that forms the staple. Eke this out with poor pastry, and we have cause enough for the multitude of dyspepsias which afflict our country.

146. The principles of bread-making are simple, if the practice is sometimes hard. Either by the use of a carbonate and an acid, or by a ferment, carbonic acid gas is set free, and separates the particles of flour, and renders the bread light. A very common method is to add carbonate of potash or soda to a dough made with sour milk, or in place of this, which has been slightly acidulated with tartaric acid. In making "light bread," a ferment of yeast is added, which, changing starch into grape sugar, sets free carbonic acid gas. If, now, the baking is done before the fermentation goes further, the bread will be sweet and light; but if acetous fermentation occurs, it will be sour.

147. It would be a blessing to our country if we had cooking schools in all large towns, and if this could be regarded as one of the many female accomplishments. We might dispense with some strumming upon the piano, and lessons in embroidery, to assure the coming generation better cooking.

FOOD FOR THE SICK.

148. Solid food should rarely be given during the progress of an acute disease, as the stomach and digestive organs are not in

a condition to furnish the fluids necessary for its proper commi-nution, and hence it does not digest, but decomposes, giving rise to irritation and other annoying results.

149. As a general rule, the severer the disease, and the further the system is from a condition of health, the lighter and more di-luted should be the food. Thus, in a high grade of fever, or in-flammation, we would give *whey*, toast-water, thin farina, or tapi-oca, weak chicken or mutton broth, etc.

150. In states of great exhaustion the food should be concen-trated, very nutritious, and yet deprived, as far as possible, of all material that can not be appropriated by the stomach. Thus we would give beef essence, concentrated chicken or mutton tea, farina, with milk, etc.

151. In all febrile and inflammatory diseases the food should be given at that period of the day in which there is least vascu-lar and nervous excitement, and it should never be forced on the patient when suffering from high fever.

152. Never give food when the patient is suffering from severe pain, as at such times it is impossible for the digestive organs to appropriate it.

153. If the tongue is heavily coated with a yellowish coat, a bad taste in the mouth, and a feeling of weight and oppression at the stomach, it is better not to give food, or at least give it in a fluid form and in small quantity.

154. Never force food on a patient when his stomach revolts at it, or if it produces nausea, oppression or pain. It is much better to wait until medicine or time has placed the stomach in condition to digest it.

155. When the digestive powers are much impaired, and it is important to give food to sustain the strength, it should be given in small quantities, and at regular intervals, like medicines.

156. If there is an absolute demand for nourishment to sustain the strength of the patient, and it can not be given by mouth, it is sometimes an excellent plan to administer it as an injection.

157. Much care is necessary during convalescence from disease *that the patient* does not eat too much, or that which is indiges-

tible. The digestive organs are now enfeebled, and, if overworked, there is not only an excess of imperfectly elaborated material taken into the system, but the exhaustion is extended to the entire system, and impairs the functions of other organs and parts.

DIGESTION.

158. The processes of digestion will only be considered here as they influence or change the character of the food, and thus favor or interfere with nutrition. I regard digestion as a very simple process, even through very complicated means may be employed in effecting it. Any one that studies this function may readily convince himself that the elements of food are not changed by it, and that the belief that they received new vitality or are elevated in form is an error.

159. Digestion is partly a mechanical, partly a chemical process, by which the organization of the food is completely broken up, so as to furnish to the tissues that perfectly plastic material which can readily be used by its minute mechanism. If we reflect for a moment, we will readily see that it is absolutely necessary that the cell formation of food shall be destroyed before it can gain entrance and circulate freely in the blood, and before it can enter into the formation of other cells in the human body. The realization of this fact will give a clear perception of the derangements of digestion, but without this it is impossible to know anything of it, much less to correct such lesions.

160. We will bear in mind, too, that digestion is buccal and salivary, gastric and intestinal, and a proper performance of each is necessary to the perfection of this function, though for a time one or even two may be but partially performed. Every practicing physician of much experience has seen the necessity of insisting that the food should be well masticated and insalivated. The merest tyro in medicine understands that the gastric part of digestion must be well performed if we are to have healthy nutrition; and it seems strange that physicians, who should under-

stand that the intestinal part of this function of digestion is the most important of the three, will persistently use means to keep the small intestines in a state of continued irritation by the use of cathartics; and that, too, at times when digestion of food is most important.

161. I will name the most important parts of this function, the more common lesions that affect the product, and draw such conclusions as will enable the reader to correct them.

162. Too much importance can not be attached to a slow and deliberate mastication of food in enfeebled conditions of the digestive apparatus, and of the entire system. This alone will sometimes make the difference between good and bad digestion, as I have had proven to me time and again in my practice and in my own person.

163. Not only is good mastication necessary, but insalivation is an essential, especially in preparing starchy foods for use. The saliva contains a material which changes starch into grape sugar, and thus commences the preparation of this food for the use of the body. It is true that the stomach may chew the food for a long time before it commences to complain, and the pancreas and glandulæ of the small intestines may do the work of the salivary glands, but sooner or later the person will suffer for this infraction of natural laws. The man who eats hurriedly, or "bolts his food," and the man who wastes his saliva in chewing or smoking, will pay the penalty in dyspepsia.

164. Gastric digestion requires a healthy condition of the stomach, a sufficient supply of good gastric juice, and sufficient muscular power. If the stomach is diseased, we determine the nature of it, and remove it. If it is enfeebled, we restore its tone by the exhibition of the milder bitter tonics. If the gastric juice is deficient in any of its elements, we endeavor to supply them. And whenever we have feebleness of function, we endeavor, by proper selection of food and restricted diet, to obtain that amount of digestion necessary to supply the waste of tissue, and at the same time improve its strength.

165. The tongue has always been considered as an index of

the condition of the stomach, and to a certain extent it gives valuable information. There are conditions of the stomach in which the digestive process is impaired or arrested, which are distinctly outlined in the appearance of the tongue. The elongated and pointed tongue, with reddened tip and edges, is indicative of *irritation.* The broad and thick tongue shows *enfeeblement,* and, when heavily coated at its base, *morbid accumulations* in the stomach; the tongue uniformly pallid, somewhat pasty, an *acid condition;* the tongue dark-red, or red and slick, an *alkaline* condition. These are the more common conditions met with in disease, which prevent the taking of food.

166. In the first of these we employ means to relieve the irritation; in the second, to stimulate the viscus to action, or an emetic to remove accumulations; in the third, we give an alkali—I prefer soda, generally using the bicarbonate in solution; in the fourth, we give an acid, the muriatic being preferable in most cases, but in some the vegetable acids are quite as good. These points I hold to be of prime importance in the treatment of disease, and whatever we leave undone, we attend to this, and to supplying a proper food; and whatever we do, we are especially cautious that it will not cause derangement of the stomach.

167. Looking at the function of the stomach in this light, the reader can see that drugs which disturb the stomach, either because they are nauseous or because they are topical irritants, must interfere with or arrest the process of stomachic digestion. When it is necessary to support the strength in exhaustive diseases, as pneumonia, some forms of bronchitis, and in most chronic diseases of the respiratory apparatus, the class of nauseants and topical irritants must be avoided. If any one doubts the unfavorable influence of these remedies, let him take them in health, and realize their unpleasant effects upon the appetite and digestion.

168. Even if we think only of the absorption of medicine, it is necessary to use such remedies with care. The process of osmose from the stomach to the blood-vessels is retarded or arrested by nausea, and a remedy, if nauseant, will sometimes fail

to get further than the stomach. In ague, a sufficient quantity of quinine may be put in a patient's stomach, and yet, on account of the nausea, or gastric irritation produced, it will do nothing but injury; whereas, if it could have been introduced into the blood, it would have cured the disease.

169. Not only this, but the stomach seems to be the center of numerous sympathies, and various functions and parts suffer when it is affected. The solar plexus of the sympathetic, the great center of vegetative innervation, is situated immediately behind it, and it receives a very abundant supply of these nerves, which will account in part for the wide spread wrong that flows from gastric lesions. I would therefore impress it upon the reader that especial attention should be given to avoid all drugs that unfavorably influence this viscus; and that gastric lesions should be carefully looked for and removed in all cases of disease.

170. As regards intestinal digestion, we understand its importance better than we do its nature, and how it may be influenced. The evidence we have as regards its importance is very conclusive, the most remarkable being the investigations made by Dr. Busch, of the University of Bonn:

"A woman thirty-one years of age, from injuries, had fistulous openings, completely separating the stomach, duodenum, and a short fragment of jejunum, from the intestine below, the upper portion of the jejunum, being torn in two. Not the least communication existed between the two portions, and the contents of the stomach and duodenum, with the gastric, pancreatic and biliary secretion, were discharged without admixture with the secretions from the intestine below.

"When admitted to the hospital the first effects of the injury had passed off, but the emaciation was remarkable, so that, though considerable improvement had taken place, she only weighed 68 pounds 2 ounces eight weeks after admission. She devoured incredible quantities of food, and for a length of time while still eating, the food first taken would make its appearance in the superior fistula, and on being questioned, she would state *that, though* feeling better, her strong desire for food was not

satisfied. In fact, though her stomach was filled, she felt an irresistible desire for aliments. The physiology of hunger was conclusively shown in this case to be composed of two factors—the one, the emptiness of the stomach and first passages, which was temporarily relieved by eating ; the other, more permanent, caused by the excess of waste over supply.

"The main object, at first, was to arrest the marasmus, by furnishing to the system a supply of nutritious material, it being evident that no matter how much was taken into the stomach the exhaustion still increased. It was attempted to lead the contents of the upper portion into the lower by artificial means, but this failing, after repeated trials, another course of feeding was adopted, with marked success. At first protein substances were injected into thelower opening, alternately with amylaceous, and subsequently eggs and meats were stuffed in by the finger. The result was most surprising, and admitted no comparison with the previously adopted feeding through the mouth. Although there was not commensurate increase of the volume of the patient, yet the muscles manifested more tone, the features lost their death-like expression, the eyes became bright, the voice returned, and the patient could sit up in the erect posture.

"We have here indisputable evidence that the small and large intestines do possess the power of digestion in a very marked degree—far exceeding the stomach and duodenum, which, with the associate glands, have hitherto received the credit. The enteric juice, contrary to the experiments of Frerichs, was found to be secreted in small quantity. During six weeks prior to her entering the hospital, the patient had but one alvine evacuation, of the size of a chestnut, consisting, probably, but of mucus and epithelial scales. Subsequently (food being introduced into the lower fistula), she had, every twenty-four hours, a copious one of ordinary consistence, though of a gray-white color, on account of total absence of bile. Most conspicious was their fetid odor. Digestion seemed otherwise to be perfect, and the fæces retained no traces of the nutriments taken. These facts, with the steady

improvement of the patient, would seem to demonstrate the dissolving properties of enteric juice upon protein bodies.

"Professor Busch sums up the result of his experiments as follows:—

"*a.* Hunger is constituted by two sensations—the first is represented by the nervous system in general, and derived from the impoverished condition of the tissues; the second originates with the nerves of the digestive organs, indicating their emptiness. The former is removed only by the required assimilation of nutritive elements, and not by merely filling the first passages.

"*b.* The peristaltic action of the intestines takes place with the same power within the abdominal cavity, and when exposed to the atmospheric air. Its propelling power equals a column of water twenty-four inches high.

"*c.* The alimentary canal has its periods of rest and action.

"*d.* The quantity of enteric juice secreted is invariably small, and of alkaline re-action. Its percentage of solids averages 5.47.

"*e.* Enteric juice is capable of digesting amylaceous and protein substances.

"*f.* Enteric juice converts starch into grape sugar.

"*g.* Enteric juice prepares protein substances for assimilation under the phenomena of putrescence.

"*h.* Enteric juice leaves cane sugar unchanged.

"*i.* Cane sugar, absorbed as such, is not discharged in the urine.

"*j.* 10. Fat, unless exposed to the action of bile, or pancreatic juice, is absorbed not at all, or in insignificant quantity.

"*k.* Food appears, between fifteen and thirty minutes after being taken, in the superior third of the thin intestine.

"*l.* Solution of cane sugar disappears in part before entering the small intestine; all that enters the latter is converted into grape sugar.

"*m.* Raw albumen, taken from hen's eggs, is directly absorbed in the stomach and the adjoining portion of the small intestines. All that descends to the lower portion of the latter is unchanged.

"*n.* Gum is not converted into sugar, but remains unchanged.

"*o*. Gelatine is dissolved, and therefore loses its coagulability.

"*p*. Casein remains partly dissolved in the digestive fluids.

"*q*. Fat is entirely emulgated by the digestive fluids, when alkaline or neutral, but partially when acid.

"*r*. The digestive liquids of the small intestines possess digestive powers over protein substances.

"*s*. The minimum of all digestive fluids entering the small intestine in the course of twenty-four hours, amounts to more than the seventeenth part of the weight of the body."

171. Looking at the function of the small intestine in this light, I object to the frequent and continued use of purgatives, especially those of a drastic character. But we also see that we have here a large field for careful observation, and one that will certainly repay the inquirer. We now know that we have certain remedies that in small doses will stimulate this part of the digestive tract. Nux vomica has an especial influence here, as has also the podophyllum and its resin, and the leptandra and its resin. Given with the stomachic bitters, we find a great aid in defective digestion.

172. *Circulation*.—That nutrition be properly performed, it is necessary that the blood containing the material should be carried to the part and distributed through it; then the cells, by their elective affinity, withdraw from the moving mass that portion required for its use, and at the same time cast out that which has already served its purpose. If strength and activity are required of a part, it is given a free circulation. If from any cause the circulation is impeded, the part loses size, strength and activity.

173. *Innervation*.—The function of nutrition is, to some extent, under the control of the nervous system, but exactly how far we are unable to say. It is more particularly the sympathetic system that influences it, probably more because it controls the circulation of the blood and the function of digestion, than by any direct influence upon cell-life. As we will have occasion hereafter to study the function of this system of nerves, it will only be necessary *to refer to* it in this place.

174. Having thus examined the factors in this somewhat complicated process of nutrition, we may trace the lesions that flow from its derangement, assign them their proper place in the total of diseased action, and be able to give intelligent assistance to relieve them.

175. We classify the derangements of nutrition as follows:

Nutrition of textures.	Increased,	Hypertrophy.
	Diminished.	Atrophy.
	Perverted.	Degeneration of tissue.
		Morbid deposits.
		Morbid growths.

HYPERTROPHY.

176. Increased nutrition depends, as we have already seen, upon one or more of the following conditions: *a.* An excess of formative force, or cell-production. *b.* An excess of food and its preparation for the nutritive processes. *c.* An increased amount of blood carried to the part. *d.* An increased innervation.

177. A very important law of our being develops itself here, that *size, strength,* and *activity* depend upon the proper and continued exercise of tissues, organs, and parts. It is given to man to have that amount of strength and activity which may be required under any circumstances in which he may be placed, and for any activities to which he may be adapted. It is according to this law of use that the blacksmith's apprentice finds an increased size and strength of arm as he continues the use, and that the danseuse attains that immense power in the muscles of the leg. The process by which it is attained is very simple—the continued use of the power we have, which increases the circulation, innervation, metamorphosis, and cell-production of a part. It is illustrated in the case of Dr. Winship, who, commencing by lifting a weight of some five hundred pounds, and adding to this day by day, was enabled, in the course of some years, to lift the *weight of* twenty-one hundred pounds.

178. This law is operative in all parts of the body, and its intelligent guidance offers the only rational means of overcoming some diseases. Is there an imperfect development of the respiratory muscles? By calling them fully into play, day after day, by appropriate exercise, they can be fully developed. Have the lungs themselves an imperfect development, this imperfection is increased for want of use; but good development is attained by full and continued use of the inspiratory power we have. Is there feebleness of the stomach, its power can certainly be increased by the judicious exercise of what it has, but it must not be overtaxed to exhaustion. In habitual constipation, we find the curative means in exercise, not in cathartics. We direct the patient to take a large glass of water on getting up in the morning, then rub the abdomen thoroughly with the hand, and go to stool immediately after breakfast. If the person adopts this plan with the determination to succeed, my experience shows that it never fails. Of course there is difficulty at first, but as week after week passes it becomes easier, and finally a habit is formed that will last a life-time.

179. It will be seen that this law is universal, as applicable to the structure and function of internal organs, as it is to the muscles of animal life. I have been accustomed to point out to my classes the importance of its recognition in mental development. Every man has the germs of an endless development of mind, and can make of himself whatever he may determine. The law is absolute: Use that thou hast to its fullest extent, and there shall be continued increase. I may call attention here to the fact that this is one of the most prominent laws of the Bible, unfolded from its beginning to its close, and as operative in the moral as in the physical universe.

180. I need but call the attention of my readers to its importance in the treatment of deformities from muscular debility. In this is the theory of the movement cure, and wherever well-regulated movement can be brought to bear there will be increased development. I insisted, some ten years since, that it afforded the *only rational* means for the relief of displacements

of the uterus; that if the abdominal and perineal muscles were strengthened, even by the passive movements of friction and kneading with the hand, a cure would result in most cases. A very large experience, and reports from the practice of many others, have satisfied me of the truth of this doctrine, and its great superiority over other means in the treatment of these affections.

181. Hypertrophy of tissue is not a very frequent element of disease, yet it is occasionally met with. The most common instances of it are thus named by Dr. Williams:

"When it affects the cellular texture of the lower extremities it appears to be a chief constituent of elephantiasis. Hypertrophy of the epidermis happens in callosities of the skin, and in corns, excited by continued irritation or pressure, which operates by causing determination of blood to the part. Another form of hypertrophy of the cuticle arises from chronic inflammation, and is instanced in psoriasis, chronic eczema, and impetigo. The cuticle is here retained, instead of being duly shed, and from its stiffness it often cracks into chaps or rhagades. In the more temporary and slight cutaneous flushes, congestions, or inflammations of erythema, scarlatina, lepra, and pityriasis, superfluous epidermis is thrown off in a peeling of the skin, or in detached scales. But ichthyosis presents the most extraordinary example of this sort of hypertrophy in excess. In this disorder the dried epidermic cells accumulate in a solid state, so as to form scales, or coarse bristle-like projections. These affections of the epidermis have their parellels in diseases of mucous membranes; but the surfaces of these membranes being bathed with liquid secretion, the nucleated cells, which stand in the place of those that on the skin form solid scales, are here thrown off with the mucus and are presented in it as floating shoals of epithelium scales, together with mucous cells and a viscid amorphous fluid. Such disordered secretion of the mucous membranes not unfrequently co-exists with cutaneous diseases; thus bronchial congestion with viscid expectoration commonly occurs in persons affected with *psoriasis* and lepra.

"The hypertrophy of the liver and spleen, so common in protracted ague, may very fairly be referred to the frequent repetition and long continuance of the enormous congestions which the disease induces in those organs. I have known a similar enlargement in them to ensue after prolonged exposure to cold and wet. In some cases, however, where there is hypertrophy, no such external cause can be detected; the enlargement then must be referred to some peculiar condition in the circulation of the affected organs, or to an unusual activity in the molecules that nourish them. To this obscure category belongs the enlargement of the thyroid gland, which is known as bronchocele."—*Williams' Principles of Medicine, pp.* 358, 359.

182. Hypertrophy is sometimes found as a compensation for loss or disease of another organ or part, or to furnish power to overcome additional resistance, or to give additional strength. As an example we may note the enlargement of one lung when the function of the other is impaired; of one kidney when it is required to do the secretion of the two; of the one extremity when the principal labor is thrown upon it. Hypertrophy of the heart is a fair example of the second, the increased size of the heart being necessitated to furnish power to pass the blood through a contracted aortic opening. The thickening of the walls of the bladder in case of stricture or other cause of difficulty in urination; the thickening of the scrotum in scrotal hernia; the thickening and toughening of feet, hands, and other portions of the skin when they are exposed to hard usage, may be regarded as additional examples.

183. *Treatment.*—Recollecting the causes of hypertrophy, we will not be at a loss to adapt treatment to the different cases. In hypertrophy of the skin, we remove the ascular irritation and stop the increased circulation of blood. In some cases, as in elephantiasis and in enlargement of the thyroid glands, the arteries giving the supply of blood have been ligated. In enlarged thyroid from irritation of the reproductive organs, the removal of this irritation arrests the growth, and frequently effects a cure.

In the treatment of corns and other callosities, a removal of the pressure and irritation will many times be followed by their disappearance. A hypertrophied bladder will be reduced or cured by dilatation or cutting of the stricture, removal of stone, or other cause of obstruction or irritation. Hypertrophy of the heart is treated with means which remove irritation and obstructions to the free circulation of blood. We remove hypertrophy of the spleen by means which give a free circulation of blood from the portal veins, and which strengthen the tissues of the organ. When there is irritation and determination of blood, these must be arrested.

ATROPHY.

184. Atrophy follows a disproportion between waste and supply, whether in consequence of an excess of the first or deficiency of the second. As already remarked, the tissues of the body are formed of material that render them short-lived, and, consequently, there must be a continuous renewal of the structure. Not only is this necessary, that the tissue may possess perfect form and function, but that the various activities of the body may be continued. In the death of tissue is generated that force by which we have conscious life and action.

185. Atrophy may be *general* or *local*, but both depend upon the same conditions, which we may briefly notice. *General atrophy* results when the daily waste is greater than the supply. It is true we recognize a condition in which the formative force is so feeble that, though there is an abundant supply of material, cell formation and its appropriation can not go on. There are other instances of atrophy, or marasmus, in which the digestive apparatus can not prepare the food for nutritive purposes, and others, as we have already seen, in which a fermentative process is allowed to proceed in the digestive apparatus until the food is destroyed. Both of these are common and easily recognized cases, and form a constituent of many chronic diseases.

186. In acute diseases general atrophy is always an attendant, for the waste continues without the power of supply. Still, even here, if proper care is given to the condition of the digestive organs, and an easily digested food supplied, extreme atrophy may almost always be avoided. A more important reason for this course, however, lies in the fact that, with even this limited amount of nutrition, all the important functions of the body are better performed.

187. General atrophy may be dependent upon the preponderance of chemical forces over the formative, which gives a greatly increased waste; or it may depend upon some lesion in the organization of the blood, whereby the material furnished by digestion is unfitted for its purpose. We also have those cases that arise from excessive secretion, as from the bowels, kidneys, and skin, whereby large amounts of nutritive material are drawn from the blood.

188. *Partial atrophy* may arise from such disease of a part as impairs its formative power. It also attends an arrest or an enfeebled circulation to a part, and occasionally from a derangement of innervation. Disease of a part is, however, the most common cause. The Indian fakir finds his arm wither and lose all power by keeping it continuously in one position. The muscular structure of any part will waste from paralysis, and will waste and become enfeebled from sedentary habits.

189. Many men, commencing life with a well-developed muscular system, find themselves, after a few years' confinement to the counting-house or store, with hardly enough to serve the common purposes of life. The respiratory organs are weakened for want of use; the stomach, bowels, and indeed all parts, suffer in the same way.

190. *Treatment.*—It will not do to say, "If nutrition is defective, give the patient a bitter tonic and iron;" for whilst this might be good treatment in some cases, it would do no good in others, and in still others it would do harm. Here, as elsewhere, we want a thorough analysis of the disease to determine the

character of the wrong. We ask ourselves the questions—has the patient the first group of conditions, good light, air, exercise? —has he good food, rightly prepared?—has he good digestion, buccal, gastric, and intestinal?—has he good blood-making, and what is the condition of the liver, spleen, mesenteric glands, and the lymphatic system?—has he a good circulation of blood, as to time, quantity, and equal distribution, arterial, venous, capillary? —is the tissue in good condition to appropriate the material or is it impaired by disease or want of use?—are the processes of waste, retrograde metamorphosis, and excretion, sufficiently active to remove the old and worn-out tissue?—is there an excessive drain either from disease or by excessive activity of the excretory organs?

191. This is a long list of questions to be answered, and especially long because the physician is to answer them himself. And yet one can readily see that they are all pertinent. If the person is deprived of light, or has a bad light, we give him light. If he has been breathing a vitiated atmosphere, we give him good air; if he wants exercise, we prescribe a right exercise; if he has been overworked, we prescribe rest; if there has been want of food, or a want of the right kind of food, the prescription is plain—food—though the selection of the right kind is not always so easy. With foods also comes the class of remedies called restoratives—iron, the phosphites or hypophosphites, cod oil, etc. The properties of these foods have already been considered, and is a matter of considerable importance. If the wrong is of digestion, we will have to determine the character of the wrong, and the means to correct it. If the blood-making organs are at fault, we employ the means that give them normal activity. If there is a wrong of the circulation, we use those means that will correct it, and give us a right circulation of blood. We give proper stimulus to the tissue by exercise, and by remedies, or, if over-stimulated, by means which will secure rest. If waste is deficient, we stimulate it; if in excess, we check it; and the same with the excretions.

192. The nutrition of a part depends upon its innervation, its circulation, its exercise, and its ability to appropriate material from the blood and weave it into tissue. When we find atrophy of a part we ask ourselves the questions—Is the part wasted from over-use, or because not used? Is there disease impairing the ability of the part to make tissue? Is there right innervation, or is the wrong in the shape of undue excitation, or feeble innervation? Is there a free circulation, arterial, capillary, and venous? If a part is wasted from over use, we see that it has rest; if from want of use, we see that it has sufficient and the right kind of exercise. If the innervation is enfeebled, we think of remedies that stimulate the part, and sometimes of external stimulation; if there is excessive innervation, or irritation, we think of its removal. If the circulation is defective, stimulation internal and external, with well regulated exercise, will be needed. If there is disease of any kind, this must be removed.

193. In very many cases we find that parts or organs are not developed from want of use, or atrophied from the same cause, and we are really obliged to grow a part by seeing that it has right use and the materials for nutrition. We find a person with a contracted thorax, and feeble respiratory organs, and we increase the size of the thorax by well regulated exercise of the upper extremities, which calls into action the external inspiratory muscles, and causes the person to take full inspirations We find a child with feeble legs, or a feeble leg which is exhausted by the effort to sustain the body. Comes rest as to the effort to sustain the body, the legs being overworked, and then frictions, with passive movement, to give the necessary innervation and circulation.

194. The muscular coat of the intestinal canal, in obstinate constipation, is atrophied from want of natural action, and the over stimulation of cathartics, until at last it will not do the necessary work. We cure the constipation by such means as will call it into action in a natural manner, and by establishing a habit (it is also a creature of habit), and thus growing a better intestinal canal. It may be the glass of cold water in the morning, the small dose of nux vomica, the small portion of phosphate

of soda, the brisk rubbing and kneading of the bowels on rising in the morning, and the regular going to stool and putting one's self in position for the evacuation.

195. Prolapsus and other displacements of the uterus are due in part, and in some cases almost entirely, to atrophy of the perineal and abdominal muscles. In some cases dissection has shown but a trace of muscular fibre where it should have been strong. In such cases the effort to sustain the pelvic and abdominal viscera exhausts the life of the tissues so that there is not sufficient force for their renewal. Especially is this the case when the care of a large household is thrown upon a woman, forcing her to work beyond her strength. In this case we want both rest and exercise—rest from excessive work, and such exercise as stimulates innervation and circulation in the defective tissues. The abdominal and perineal supporter secures the first purpose, in supporting the organs, and taking off the excessive work while the woman is on her feet during the day. The second purpose is obtained by kneadings or frictions with the hand, and very well in some cases by the use of electricity. This movement cure has given such satisfactory results that I strongly recommend it for the radical cure of these displacements.

PERVERTED NUTRITION.

DEGENERATION.

196. When in the process of nutrition one element replaces another, so that, though the outer form may be preserved, the elemental structure is changed, we say there is degeneration of tissue. We can readily see what causes might lead to this transformation, though it is difficult, many times, to understand why they should exist.

197. The most frequent cause of degeneration may be found in an enfeeblement of formative power, and in a lesion of cell production. Thus we notice that when muscular tissue is inca-

pable of reproducing itself the cell formation goes on to the production of fibrous or fatty tissue—lower grades of organization.

198. In other cases the lesion may be partly of digestion, assimilation, and of the blood, whereby the *plasma* or material for nutrition is changed. We know there are such lesions, and we have other derangements that show it more clearly than these.

199. We may specify four kinds of degeneration—the *fibrous*, *granular*, *fatty*, and the *osseous*. Before these we might study that enfeeblement of nutrition that gives us feeble and imperfect tissues, and of necessity a feeble and imperfect performance of function. To these may be added a condition known as *softening*, in which we do not recognize any special change of material, but simply a want of proper formation and connection.

200. *Simple degeneration*, or impairment of tissue, is frequently met with, and is a condition of many chronic diseases. Either from bad light, bad air, want of exercise, bad food, imperfect waste and excretion, or some general or local disease, the tissues lose the power of producing strong cells, and the result is a feeble and imperfect tissue, which, though not changed to a lower form, and still capable of renewing itself, can not perform its functions. This may be general, embracing the entire body, or it may be local, confined to a particular part or organ. If general, the entire life is feeble; if local, the particular function is impaired.

201. We diagnose the general lesion readily, by noticing the fact that the person seems of ordinary stoutness, and yet is very feeble, and that the soft tissues sit upon the bones like a badly fitting suit of clothes. In other words, there is a want of expression in the individual, the muscles that give expression wanting strength. When we feel of the tissues they are soft and doughy, and do not possess that quality which we call *tonicity*. The local lesion is usually characterized by the same symptoms, to which we add the feebleness of function without evidence of other structural disease.

202. There is only one cure for such patients, whether the impairment be general or local, and that consists in a renewal of

the life by the renewal of tissue. The old and feeble tissue must be removed through the excretory organs, whilst at the same time new tissue is made under better conditions. It does not do to carry away the old man too rapidly, or we may lose him; and we are not benefited unless, by looking after the food, the digestion, blood-making, circulation, condition of tissue, and innervation, we make an improvement in the tissue that is being built.

203. *Fibrous degeneration* is principally confined to muscular structures, the fibrous tissue replacing the muscular structure in the same fibrillæ. As it progresses the part loses its power of contraction— is not so obedient to the will. The causes above-named are sufficient to produce this degeneration, and not unfrequently it arises from these. In other cases it is dependent upon an inflammatory process of the structure or its immediate vicinity.

204. We occasionally meet with this degeneration in internal organs, both muscular and glandular. Fibrous degeneration of the heart is occasionally met with, and it is claimed to be almost wholly dependent upon inflammatory action. Fibrous degeneration of the liver, the so-called *hob-nailed liver*, is one of the severest affections of this viscus, and of course, in so far as fibrous tissue has replaced the secreting structure, it is irremediable. The same change is occasionally noticed in the spleen, pancreas, and kidneys, but is rarely recognized during life.

205. *Granular degeneration* is that condition in which granular material of low organization takes the place of the normal structure of a part. If we except softening, this is the *first* distinct degeneration. We may find this transformation in all structures, at first in but small quantity, but gradually increasing until it replaces large portions of tissue. Granular degeneration of the kidney has been studied to a greater extent than any other, and may be regarded as its most common form.

206. As regards the nature of this granular material and its origin, I may quote from Virchow:

"At present we call the body a granule-globule, and regard it as the first distinct proof of degeneration when the cell no longer retains its existence as a cell, but merely its former shape remains, after the parts which really constitute a cell—namely, the membrane and the nucleus—have completely passed away. After this, in accordance with external circumstances, either a complete destruction of the parts ensues, or they may still persist, coherent. If, namely, we have to deal with very soft parts, in which much fluid or juice has been present all along, the granules fall asunder. The medium which bound them together, and enabled them to retain the globular form,—namely, a remnant of the old cell-contents—is gradually dissolved. The globule breaks up into a crumbling mass, which is often still somewhat coherent in places, but from which one drop of fat after another is detached, so that the correspondence with milk is very beautifully displayed."—*Virchow*, p. 379.

207. *Fatty degeneration* is the most common of these perversions, and may occur in any organ or part. Commencing in a tissue, the microscope detects single rows of fat-cells alternate with the muscular fiber. As it progresses further portions of the muscle present a pale appearance, and here their development will be found abundant, and seemingly taking the place of and arranged like muscular fiber. And in glandular organs we find a similar arrangement of fat-cells to that of the original tissue, so that we are constrained to believe that the fatty matter has really taken the place of the muscular.

As regards the histology of fatty degeneration, I may again quote from Virchow:

"We have now compared a series of examples of fatty degeneration, and may henceforth confine ourselves to the consideration of genuine *fatty metamorphosis*, in which the normal structure of the part is ultimately destroyed, and the place of the histological elements is gradually occupied by a purely emulsive mass, or, more concisely, *fatty debris*. It makes no difference whether it is a pus-cell, a connective tissue corpuscle, a nerve or muscular

fiber, or a vessel, which experiences the change; the result is always the same, namely, milky debris, an amorphous accumulation of fatty particles in a more or less highly albuminous fluid. But though we hold to the agreement of all cases of fatty metamorphosis in this respect, it by no means, however, follows that the importance of this change as a morbid process is in every case the same. This you may at once infer from the circumstance that, while I have introduced this process to your notice in the category of purely passive disturbances, one of the very structures which we most frequently find in it, the granule-globule, has been regarded as a specific element of inflammation. For years an inflammatory globule (exudation corpuscle) was looked upon as an essential phenomenon in the process of inflammation; and in fact, the frequency with which cells in a state of fatty degeneration are found in inflamed parts, affords sufficient proof that in the course of inflammatory processes, which it is impossible we should ever regard as simply passive processes, such transformations must take place. It is, therefore, very essential to find a means of distinguishing between the two classes. This offers, indeed, in particular cases, very great difficulties, and according to my conviction the only possible method by which clear notions upon the subject can be obtained, consists in examining whether the condition of fatty degeneration is a primary or secondary one; whether it sets in as soon as the disturbance can be perceived, or whether it does not occur until some other perceptible disturbance has gone before. Secondary fatty degeneration, or that in which this peculiar transformation occurs only in the second place, generally succeeds to a first and active stage. A whole series of those processes which we do not scruple to call inflammations, run their course in such a way that a fatty metamorphosis sets in as the second or third anatomical stage of the change. Here, therefore, the fatty degeneration does not arise as a direct result of the irritation of the part, but where we have the opportunity of more accurately tracing the history of the changes, it nearly always turns out that the stage of fatty degeneration has been preceded by another stage, namely, that of *cloudy*

swelling, in which the parts enlarge and increase in extent and density, in consequence of their absorbing a large quantity of matter into themselves. Absorbing I say advisedly, because I hold it to be untrue that the part is in any way forced by external influences to take up this matter, or that it is inundated with exudation proceeding from the vessels, for the same phenomena present themselves also in parts which have no vessels. It is only when the accumulation has attained such dimensions that the natural constitution of the part is thereby endangered, that a fatty disintegration is set up in the interior of the elements. Thus we may designate fatty degeneration of the renal epithelium as a stage of Bright's disease (or, as I say, parenchymatous nephritis), which has been preceded by a stage of hyperæmia and swelling, in which every epithelial cell accumulated a large quantity of cloudy matter in itself, without there having been originally a trace of a drop of fat observable. Thus we see that a muscle under the influence of agencies which it is universally conceded produce inflammation, as for example after wounds and chemical corrosions, swells up; that its primitive fasciculi become broader and more clouded; and that, as a second stage, the same fatty degeneration commences in them which at other times we see primarily arise."—*Virchow*, pp. 391–393.

208. The same author describes another form of degeneration which he terms *amyloid*, and which consists in the deposit of a starch-like material between the elemental tissues. In other cases "all the constituents (parenchyma and intestinal tissue), as such, become directly filled with a substance also of an amyloid nature, and are gradually infiltrated with it, just as tissues become infiltrated with lime in calcification." Our author determines the character of this material by the employment of iodine, followed by the very cautious use of sulphuric acid, when a perfectly blue color is developed.

209. *Osseous or calcareous degeneration* arises from the same causes, and is found in the same parts as those varieties just named. In this case the tissues seem to take the place of a provisional cartilage, and the osseous matter is deposited around the

cells. In some cases Virchow concludes that the process is really one of development;—that in the part about to undergo ossification, there is a rapid cell formation, as in the development of bone.

210. Osseous degeneration is most frequent in the permanent cartilages. In old age there is frequent ossification of the intercostal cartilages, and rarely of the intervertebral and of the articular. Ossification of the laryngeal cartilages is also quite frequently met with in old age, and as produced by disease. The most serious lesion of this kind is the ossification that occurs in the heart and arteries, and in the valves. Occasionally it gives rise to such symptoms as call attention to it, but at other times it is not recognized until possibly the sudden giving way of an artery or the wall of the heart causes sudden death, and the examination of the cadaver determines the cause.

211. To these degenerations I add *softening*, as being of the the same class, and many times preceding them. In this case the tissues are soft and friable, are readily separated and torn, and in every respect seem to have lost that peculiar property we call tonicity. There is here a gradual loss of vitality; and, though the tissues reproduce themselves, they do it in a less and less perfect form. They do not lose their function at once, but there is a gradual enfeeblement of it as this degeneration proceeds.

212. The most marked example of this degeneration is *softening of the brain*, which has engaged the attention of several writers in the last few years. Overactivity and prolonged mental exertion have been regarded as the most common causes, though great and long-continued emotional excitement will also produce it.

213. We have instances of this degeneration in internal organs. I have seen one case of friable lung, in which I was positive that death resulted from softening of its tissue. The friable spleen, liver, and kidneys, are spoken of in pathological anatomy, though I doubt whether a softening of these organs has yet been recognized as a pathological state by any writer on medicine.

214. Degeneration is not easily recognized, and in a majority

of cases it progresses until the destruction is beyond remedy. Of course I exclude cases of granular degeneration of the kidney and degeneration of the liver, which usually, though not always, present characteristic functional disturbance. The gradually decreasing power of continued exertion is an important point in the diagnosis. Persons having degeneration will find themselves incapable of prolonged exertion; this, it will be recollected, is a prominent symptom of softening of the brain. A want of sharpness in the wave of blood as it passes under the finger is an additional element. If we add to this the *baggy* appearance of the tissues, especially those influenced by the superficial muscles, we have the principal points that I have depended upon. There is something in the appearance of the person that strikes the observant physician as *necrobiotic,* though he may not be able to tell exactly what it is; and I do not wish to inculcate a dependence upon impressions that can not be analyzed.

215. *Treatment.*—As regards the treatment of these lesions, I think it will be admitted that the older methods have done far more harm than good. In my practice I strictly observe the rules laid down in (18); believing that if I can increase the formative power, and good digestion and secretion, I may effect a cure in the earlier stage of the degeneration. The more powerful bitter tonics and stimulants, as quinine, strychnia, phosphoric acid, and iron, are very useful in these cases. Aitkin's syrup of the phosphates of quinia, streyhnia, and iron, or, as it is familiarly called, *Compound Tonic Mixture,* is an excellent preparation. With this and a small portion of sound wine, we advise an animal diet. The other part of the treatment looks to the activity in the waste of tissue, and its removal by the skin, kidneys, and bowels. Thus keeping both waste and supply active, but equal, we find that the degeneration shortly yields, even when it has existed for some time and been quite severe.

DEPOSITS.

216. To avoid confusion, I employ the ordinary classification, though in this instance the term deposits does not clearly express the condition, and, indeed, tends to lead the student into error. There are no deposits in vital processes, but nutrition even when diseased is wholly a selection or election by the cells from the blood. Such processes are considered under this heading. Then we have others, in which at first there seems to have been an effort at organization, but this soon fails, and we have an exudation of inorganizable material.

217. Deposits are divided into three varieties, *euplastic, caco-plastic,* and *aplastic.* The first is that in which the exudation is capable of normal organization; the second in which it is capable of but feeble or imperfect organization; and the third, in which it is not susceptible of organization. We have first to regard these nutritive processes in the repair of injuries; secondly, the same processes as a cause of disease; and third, the deposit as a simple exudation impairing the vitality of the part into which it is thrown.

REPAIR OF INJURIES.

218. Most writers have claimed that a wounded or injuried part could be repaired in four different ways: 1. By immediate union. 2. By the first intention, or union by adhesion. 3. By the development of new tissue. 4. By suppurative granulation. I am satisfied there is no such thing as immediate union; indeed, it is impossible that there should be such. In the injury, even an incision with the finest cutting instrument, there is a destruction of tissue, and even if there were not, it is absurd to suppose a coaptation so exact as to bring accurately together the divided capillaries and cell structures. The third and fourth processes are also the same—the development of a new tissue as a bond of union—and it is absurd to speak of it in one case as

arising "from a nucleated plasma," in the other, "from suppurative granulation."

219. We may assert that the repair of injuries is in but two ways: 1. By adhesion, or, as we may still call it, *first intention*. 2. By the formation of that fibrous connective tissue known as a *cicatrix*. In the first case there is a perfect condition of the material for repair, and a good coaptation of the parts; while in the second there is an imperfect coaptation of the parts, and causes acting to diminish the plasticity of the effused lymph.

220. In recent wounds we notice in a short time an exudation of material upon the free surfaces, which gives them a glazed appearance. This is the reparative material commonly known as coagulable lymph, but it is better to describe it "as the free interstitial plasma which, before the wound was made, was about to give form and substance to the solid structures, to muscle, connective tissue, or membrane." It was not a secretion, but a pre-existent fluid which the knife disclosed, or rather exposed. "If we tap a muscle under firm pressure, we can squeeze out this fluid. Squeezed from the limb of a sheep immediately after death, it is a thin, slightly-colored alkaline serum, very easy coagulable. It is almost destitute of salts, and it has a mean specific gravity of 1025. It decomposes with extreme rapidity under circumstances favorable to change, but it can be kept free of decomposition by extreme cold for an unlimited time."

221. From the approximated tissues a proliferation of cells immediately takes place, which employing this plastic exudation, soon form it into tissue analogous to that they were derived from. Here there is no layer of adventitious tissue, because the cell-growth is from the original tissue, and the material employed is that natural to the nutrition of the part. We have heretofore seen that there was a *cell territory*, limited, in extent, it is true, but over which the cell possessed entire power. Now, if the separation of the parts are such that the influence of the cells from adjacent sides does not embrace the entire exudation, this union by first intention can not take place. In many cases we observe

a union in part by first intention, and in part by the formation of fibrous tissue.

222. Dr Richardson claims that "when a wound does *not* heal by first intention, it is prevented by a layer of decomposing albuminous matter lying between its divided surfaces. This layer may be very thin and transparent, or it may be thick and dense; it may give an offensive odor, or it may (when it exists in purulent matter) give little odor; it may be transparent and colorless, or it may have various shades of color from light gray to almost blackness. If we examine this fluid chemically, we find that it consists of modified albuminous matter, with or without fat; if we bring some of it in a state of actual decomposition into contact with other matter albuminous in construction—such as blood, serum, dissolved fibrin, or even dissolved casein—it quickly transforms all these into decomposing or decomposed matter like to itself, the conditions for decomposition being supplied."

223. The same writer claims that this nutritive plasma in its normal condition is *alkaline*, but when exposed to the air, and oxidized, becomes acid, and then undergoes speedy decomposition. Suppose, then, the oxidation is established, what is the sequence? The sequence is disposition to further change. The fluid modified in character, is no longer a fluid ready to enter into substance with the solid tissue with which it is in contact. It lies as foreign matter, preventing adhesion, and communicating acidity to the new plasma that is pouring into it. From this state there may be three results:

"*a.* The patient, being healthy and well provided with good plasma, and air, and specially water being excluded from the wound, the new plasma may neutralize and throw off the old, and with some discharge there may be more or less of spaces in which there is healing by the first intention.

"*b.* The condition being less favorable, the changed plasma, acting as a foreign body, may excite the production of great heat in the part—inflammation, so called. In this state the plasma will be retransformed into a plastic, coagulable fluid, which will form adhesions with partial healing and some production of pus.

Or, in this state all the fluid may be transformed into purulent fluid—abortive plasma—which will be alkaline but not adhesive, which will protect the parts shielded by it from external oxidation, and will allow the natural plasma to build up new tissue from beneath—healing from the bottom.

"*c*. There is one more major condition. The plasma, from becoming in the first place of acid reaction, may run rapidly into alkaline decomposition, with complete disorganization of all the colloidal parts, the interstitial plasma, the effused blood, the fibroid membrane, the osteoid and tendinous gelatine. When this disintegration occurs the constituents of the plasma are transformed into new and soluble compounds, susceptible of re-absorption into the organism, and even of absorption into other organisms. During this form of degeneration, not during the purulent form as was once supposed, the systemic malady, mis-named pyæmia, finds its origin."

224. Upon this reasoning he bases the following treatment after surgical operations: "Having exposed this fluid, he leaves a surface of it that has been exposed whenever he closes the wound; and this is the great point to remember, that healing by the first intention, or no such healing, turns precisely on the physical condition in which this fluid is thus left. If the wound be closely and well bound up before the fluid has had time to undergo change, then the fluid passes into solidification, becomes a bond of union of the divided parts, and sets up true healing by the first intention. But if the fluid has time to undergo change, to pass into one of the stages of its decomposition, then it does not solidify, and there is no true healing of a direct kind. Fresh fluid coming down presses before it the original fluid, and the process, as it is vulgarly called, of 'healing from the bottom,' is the natural sequence, if the case goes well. It is astonishing how quickly, in some cases, the interstitial combining fluid undergoes change on exposure to the air."

225. *Union by Cicatrization.*—Though we may admit that oxidation of the nutritive plasma will retard the reparative process

and that a treatment based upon Dr. Richardson's theory would be a good one, yet, in itself, it is incorrect. I gave it as the *very latest* theory, and as containing many useful suggestions. This process, however, has been observed in all its parts, and we are able to say in just what it consists.

226. Recollecting first that cells are never generated *de novo*, but must have a parentage, we will not adopt the common error of "nucleated blastema," or any property in the exuded lymph other than its capacity of being organized. The cell formation, which effects this organization, is always from the adjacent tissue, the rapid multiplication of cells that we observe being the result of the irritation or excitation of the part. There is but one tissue in the body that is *universal*, and that is connective (fibrous) tissue. All other tissues, except the adipose, are developed only in their natural position, and in the exact order in which they are destined to act. Therefore this *proliferation* of cells is from the fibrous connective tissue entirely, at least after we pass beyond the cell territory. I believe that we thus rationally account for the cicatrix always being fibrous.

227. The process of organization is briefly as follows: From the capillaries immediately adjacent to the injury is exuded a plastic lymph, and at the same time an increased cell formation occurs from the sound tissues adjacent. Immediately the lymph is drawn upon for the formation of other cells, and organized in the vicinity of cells as heretofore named. In this process new capillaries are formed, pushing out, so to speak, in the newly formed lymph. From these capillaries, and from these cells, we have again a new supply of plastic material, and a new supply of cells for its organization, and thus the process continues until the part is filled up. In looking at a wound or an ulcer in process of healing, we notice those irregularities termed granulations. Each of these consists of one or more capillary loops, and by watching them attentively with a magnifying glass, we may observe this exudation; and, though the cells are beyond our vision, we can see that a process of organization is going on.

228. There is usually an excess of lymph over the organizing

power, and just in proportion to this is the formation of pus. If the exudation is large, pus will be freely formed, and if the exudation is moderate, and the organizing power feeble, the purulent product will be large. But if the process of organization corresponds with the amount of lymph furnished, then there will be but little pus, and in some cases none. I am sure that I have seen the process of healing progress with rapidity and with the production of so small a quantity of pus, that an ordinary observer would say there was none This was under a continuous water-dressing. I claim, therefore, that the formation of pus bears no relation to the healing process, only there is more lymph furnished than can be organized.

229. In some cases the process of healing is slow, because there is not sufficient lymph, or because it is not of good quality; but in a majority of cases we find that it is slow or rapid in proportion to the formative power in the cells. In many cases, where a considerable amount of material is to be replaced, we find the nutritive process, which was at first active, becoming less and less until, finally, it ceases entirely. In some cases the cell-growth continues, but they become smaller and smaller, until they no longer have an influence over the plasma. In other cases there is frequent division of the nucleus, without new cell-growth, so that the cells can not be distinguished from pus-cells.

230. We may at this point notice the histology of pus, though the subject will be examined more in detail hereafter. Pus-cells have their origin from *formative* cells, and we may see from the above how this change takes place. It would seem that the cells were there furnished for the organization of the part; but losing vitality, or being imperfectly developed, they degenerate into pus-cells. Thus both cells and the fluid of pus have their origin from the sources of nutrition.

231. The cicatrix varies in organization and strength according as the formative force is active and the material furnished is good; and just in proportion as either the one or the other of them are at fault, we find the product varying from the *euplastic* to the *cacoplastic*.

232. *Circumstances favoring the Healing Process.* In the case of a recent wound the parts should be accurately adjusted, and so supported that this apposition may be maintained. Entire rest of the part is also necessary to accomplish the above, and to facilitate the formative process. Then, if the part be kept excluded from the air, by coagulated blood, by a water-dressing, the application of collodion, an antiseptic dressing, or other means accomplishing the same objects, we may expect a union by adhesion, and the part will be perfect in form and function. Where the vitality of a part is impaired, as when roughly cut or torn, or where the part is bruised, or when a portion of the tissues are lost, union by first intention can not be expected.

233. Union by cicatrization is favored by giving the tissues proper support, and by providing a free exit for such broken-down tissue and pus as may have to be removed. In ordinary cases pus is the best dressing, and should not be roughly removed, as is done by some practitioners. If the circulation of the part is feeble, we have means to increase this; and if the production of cells becomes impaired, there are certain local applications which will stimulate the nutritive process. Where a large part is to be restored, it is important that attention be given to the digestive process, to the circulation of the blood, and to excretion, as the repair can not go on unless a sufficient supply of good material is furnished for use. In the more serious injuries, as in large abscesses and *capital* operations, the recovery of the patient will depend upon this. I am very sure that thousands of persons have lost their lives, from the absurd practice of depletion to prevent inflammation.

234. Is inflammation necessary to the process of repair? It is claimed by some that it is not only necessary, but that it is the cause of repair, and hence they have elevated inflammation to a *physiological* (?) process, or, as they express it, "the best action that nature can set up under the circumstances." Now, if we examine the process closely, we will find that not only is it not necessary, but that just in proportion as it exists it obstructs the process. All practitioners who have had any experience realize

this in their practice, whatever may be their theory; and they are careful, in whatever they do, to control inflammatory action.

235. Not only must we be careful to control inflammatory action, but sympathetic fever as well. Many times we flatter ourselves that union is going on well, and the process of healing will soon be accomplished, when our patient has a chill, followed by febrile action, arrest of secretion, etc. On looking at the wound we find that the process of repair is arrested, and if this continues, the union that has been effected will be broken up, the pus will increase, cease to be laudable, and at last will become a dark and ichorous sanies. Typhoid symptoms manifesting themselves in a surgical fever, soon show themselves in the wound.

236. The use of the sedatives, specific medicines as they may be indicated, means to establish and continue excretion, relief from nervous irritation, a good condition of stomach and digestive tube, remedies that control blood poisoning and sepsis, are all as important in surgical as in idiopathic fever.

EUPLASTIC DEPOSITS.

237. We have just seen that the repair of injuries is, in part, by the organization of euplastic material, which is always fibrous in character. We have now to notice the same euplastic organization in parts where it is not a process of repair, but rather of destruction. In some cases the inflammatory process proceeds in such a manner that it does not destroy the vitality of the part, but causes a deposit (exudation) of plastic lymph, which, receiving cell germs from the adjacent connective tissue, becomes organized. This adventitious tissue is formed in the interstices of the normal tissues, and may not destroy the normal function of a part, though it always impairs it.

238. As examples of this, I may instance the condition of the lung sometimes occurring in chronic pneumonia, and sometimes resulting from an acute inflammation, in which more or less of

this fibrous formation exists. I have examined portions of lung in which it had become organized to such an extent as to render the lung solid, and yet the original tissue still remained. The same process occurs in the liver, spleen and kidneys, and indeed all parts.

239. When occurring in the skin or adjacent connective tissue, or the superficial muscles, it is called *induration*. When upon the free surface of a serous membrane, the exudative matter organizes into false membranes, and forms adhesions between parts naturally free, as the surface of the pleura, peritoneum and pericardium. When it occurs in the neighborhood of articulations, it obstructs movement and causes fibrous anchylosis. And in the case of muscles and tendons, it obstructs motion and causes deformity.

240. We may notice one property of euplastic tissue particularly as being troublesome, and the effects of which have to be constantly guarded against: this is the tendency to contraction after organization. The most familiar example of this is seen in the continued contraction of cicatrices closing wounds, which is sometimes very marked and continues for many months. The contraction in the cicatrix from burns will possibly give the most marked illustration of this, as it causes great deformity in some cases. In internal organs we notice this same property, and we have the contraction in lung, liver, and in adhesions, just the same as in burns.

241. It is a little singular that the organization of lymph in the formation of adhesions, as in pleuritis and peritonitis, as well as lungs, liver, and spleen, is increased by what has been termed the "antiphlogistic treatment." This would lead us to believe, that the amount of fibrin in the blood determined to some extent this deposit and its organization, according to the experiments of Majendie. Blood-letting, mercury, antimony, free catharsis, blisters, and all means that deplete, and those that interfere with digestion, are liable to give these unpleasant results. Whilst a rational treatment that controls the pulse and the temperature,

relieves nervous irritation, and establishes normal secretion, is rarely, if ever, followed by such adhesions.

CACOPLASTIC DEPOSITS.

242. We have now to consider a lower organization than the above, and yet a *distinct* organization. I am very particular that this shall be understood, as it is important that we do not confound it with the aplastic deposit, which is not susceptible of organization.

243. We may trace two causes of cacoplastic deposits, either one of which, or both, may be operative in any individual case. In the one the defect is in the plasma, or formative material; in the other it is in cell-growth, or formative power.

244. Instances of the first lesion are very common, and may be from hereditary or acquired defect in life, as manifested in digestion and assimilation, and in blood-making. That vague disease, scrofula, presents many examples of this. From a slight irritation of a part there is an exudation of material into its structure. It is not transformed into fibrous tissue, as is the case with the euplastic deposit, but receives a low organization. Cells are furnished from the adjacent tissue, but they are irregular in form, and are imperfect in their influence upon the plasma, which is arranged partly in fibers, partly as granular material, and *without* the formation of capillary blood-vessels. Such deposits are frequently seen surrounding lymphatic glands, and are also found in the neighborhood of bones, beneath the periosteum, and in the structure of organs.

245. The material is capable of maintaining life for some length of time, as we observe in all these cases, the enlargement remaining the same for months. It is not very susceptible to absorption, and hence the failure of many remedies to affect it, and it will finally break down, forming an imperfect pus, and more likely to destroy the integrity of the adjacent parts than an ordinary suppuration.

246. In the second case, the vitality of the part has been impaired, most frequently by an inflammatory process, though it may be from injury, or the exhaustion of overactivity. With this enfeebled vitality the formative process must necessarily be defective, even though the plasma be good.

247. Many cases of both these forms are classed as tuberculous, and yet it seems to me that the distinction between the two can be clearly drawn. It is true that an exudation of this material into the lungs forms one variety of phthisis pulmonalis, and, as I claim, gives the only cases that recover. This assertion is easily proven, if we examine the processes of cure: 1, by absorption; 2, by partial organization; and 3, by cretafaction. An *aplastic* deposit is never absorbed, can not be organized, can never serve as a basis for bony deposit, and will, in every case, break down in a longer or shorter period of time. While *cacoplastic* can be absorbed, is organizable to a limited extent, and may be the basis of bony deposit or cretafaction.

248. We have yet to consider another cause of these deposits, the action of a poison within the blood, impairing the formative fluid, and entering into the composition of textures, impairing their formative power. The most prominent example of this is the syphilitic poison, which, in its severer forms, so commonly manifests itself in cacoplastic deposits.

249. *Treatment.*—Regarding the causes first mentioned, the treatment seems very plain and rational, and I know it is very successful. The defect in the plasma or blood is corrected by such remedies as place the digestive organs in good condition, and stimulate them to a proper performance of their function. The use of bitter tonics and the more permanent stimulants is of much importance. Add to this the restoratives, iron, phosphorus, etc., and an easily digested and nutritious food, and we have the first part of the first condition complete. The second part of this is to keep the blood free from effete material, which always tends to lower the vitality of the newly-forming blood.

We accomplish this by the use of such measures and remedies as cause healthy action of the skin, kidneys, and bowels.

250. A local debility or defect of formative power may sometimes be remedied by the arrest of local processes of disease, as of chronic inflammation. In other cases, by giving the part rest, when it is caused by overwork. In still others we may, by special local or general remedies, stimulate the part to increased activity, especially by acting upon the nervous and vascular systems.

APLASTIC DEPOSITS.*

251. Each of the three deposits, euplastic, cacoplastic, and aplastic, are derived from the blood, are albuminous (protein) in form, and have their origin from histogenetic food through the process of digestion. They differ in plasticity or power of organization, the first possessing this power in a good degree, the second in a feeble degree, and the third to so limited an extent that

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*"With reference to the relation of form and nature, there is a question of really cardinal importance, concerning which, in the interest of mankind, a certain degree of unanimity ought soon to be arrived at, namely, what is properly to be understood by the term *tubercle*. The same difficulties which I have just described to you, are again encountered in the case of tubercle in a still higher degree. The old writers introduced the name tubercle merely to express an external form. Every thing was called a tubercle which manifested itself in the shape of a small knot. It is, as you are no doubt aware, by no means so very long since this term was employed in the most loose manner. Carcinomatous and scirrhous tubercles were talked about, scrofulous and syphilitic tubercles were distinguished from one another, and these terms are still preserved in France. Cancer too, in old times, was not by any means exclusively employed to designate a real tumor, but noma (cancer aquaticus) was considered to have as much right to the appellation as a chancre (cancer syphiliticus).

"Now, in the course of the present century, endeavors have been made gradually to exchange these somewhat superficial views for more accurate conceptions, and here also it is to Laennec especially that credit is due for having sought for precise denominations. Still he himself in his turn has been the cause of this matter's having fallen into a state of

in reality we may say not at all. This *is* tubercular material, as generally understood, wherever it may be deposited.

252. We can not regard the *aplastic* as having but one origin, and that a *defect* in the blood, or rather in the formation of blood. This defect is to a certain extent hereditary, to a certain extent

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almost irremediable confusion. For, as you no doubt recollect, he asserted that tubercle presented itself in the lungs under two different aspects, the so-called *tubercular infiltration* and *tubercular granulation*. Now, inasmuch as infiltration signifies something completely at variance with the old notion of tubercle, since it does not at all imply the presence of small knots (knotchen), but expresses an equable pervasion of the whole parenchyma, a track was hereby opened, in following which the old idea of tubercle has more and more been departed from. As soon as the infiltration of tubercle had once been created, and the form of the neoplasm had thereby been abandoned, the infiltration was generally, as being more extensive, and therefore more instructive, taken as the basis of subsequent descriptions, and attempts were made to find out in what respects it really agreed with the other previously known forms of tubercle. It was in this way that the cheesy stage of tubercle came to be gradually adopted as the common generic characteristic of all tuberculous products, not merely as the principal aid in diagnosis, but as the starting-point for the interpretation of the process in general. It was in this way, in particular, that the idea came to be entertained that tubercles could arise simply by any exudation's losing its water constituents, growing thick, turbid, opaque, cheesy, and remaining in this condition.

"The term tubercle-corpuscles (corpuscules tuberculeux), which is, you, know, still in very frequent use, has reference to just this cheesy stage, and the accurate description which Lebert has given of them amounts to this—that they are formations which correspond with none of the known organic forms, and are neither cells nor nuclei, nor any thing else of an analogous nature, but appear in the form of little, roundish, solid corpuscles, which frequently have particles of fat scattered through them. But if the development of these corpuscles be investigated, it is easy to convince oneself that, wherever they occur, they arise out of previous organic morphological elements, and that they are not by any means the first bungling products, unfortunate essays of organization, but that they were once well grown elements, which by an unhappy chance were early checked in their development, and early succumbed to a process of shriveling. You may with certainty assume that where you meet with a large corpuscle of this description, a cell had previously existed, and where you find a small one, there once had been a nucleus, inclosed perhaps within a cell.

"Upon examining the point which has been the leading one in the doctrine of tuberculosis recently advanced, namely, tubercular infiltration of the lungs, we readily arrive at the result which Reinhardt has

acquired; and it is difficult to determine in most cases which of these preponderate. As already observed (16), the formative power or vitality of persons varies, just as we observe the formative power of tissue to vary. In some so feeble that it is exhausted in a few days, a few months, or, at farthest, a few years.

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set down as the final one, namely, that tuberculosis is nothing more than one of the forms presented by inflammatory products when undergoing transformation, and especially that all tuberculous matter is really inspissated pus. In fact, what has been termed tubercular infiltration can, with few exceptions, be traced to an originally inflammatory, purulent, or catarrhal mass, which has gradually, in consequence of incomplete reabsorption, fallen into the shriveled and shrunken state in which it afterward remains. But Reinhardt was deceived when he thought he was examining tubercle. He was led astray by the false direction which had been given to the whole doctrine of tuberculosis from the time of Laennec until his own, especially through the fault of the Vienna school. If he had confined himself, in his investigations, to the form assigned of old to tubercle and knot (granule), if he had examined the constitution of the knot in its different stages, and had afterward compared the different organs in which knotted (granular) tubercle occurs, he would unquestionably have arrived at a different result.

"It may, at least according to what I consider to be the correct view of the matter, certainly be said, that the greatest part of whatever in the course of tuberculosis does not appear in the form of granules, is an inspissated inflammatory product, and has, at any rate, no direct relation to tubercle. But by the side of these inflammatory products, or also independently of them, we find a peculiar structure (the knot, granule) which, if they are to be regarded as real tubercle, would no longer be included in the ordinary classification; and it is certainly an extremely characteristic circumstance that in France, where the terminology of Lebert has become the prevailing one, and the *corpuscules tuberculeux* are wont to be regarded as the necessary accompaniments of tuberculosis, bodies, concerning the tuberculous nature of which there can be no doubt, have quite recently been set down as something altogether peculiar, and which had hitherto remained undescribed. For one of the best, nay perhaps the best, micrographer France possesses, Robin, has, in his examination of cases of tubercular meningitis, deemed it impossible to regard the little granules in the arachnoid (pia mater), which every body looks upon as tubercles, as being really tubercles, because the dogma now prevails in France, that tubercle consists of solid non-cellular corpuscles, and in the tubercles of the cerebral membrane cells in a state of perfect preservation are met with. To such curious aberrations does this track lead, that one ends by being unable to find a name for real tubercle, because so many accidental objects have been confounded with it, that what was sought for, or even what had been found and was already grasped, has, in

This defect is in the formation of blood, as it is in cell formation, and usually in very equal proportion.

253. Now, I claim that just in proportion to this want of vitality is the admission into the blood of material of low organization, material that can not be used in the formation of tissue,

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consequence of the attention of observers being diverted by these objects, been allowed to slip out of one's hand again. I am of opinion that a tubercle is a granule, or a knot, and that this knot constitutes a new formation, and, indeed, one which, from the time of its earliest development, is necessarily of a cellular nature, and generally, just like all other new formations, it has its origin in connective tissue, and which, when it has reached a certain degree of development, constitutes a minute knot within this tissue, that, when it is at the surface, projects in the form of a little protuberance, and consists throughout its whole mass of small uni or multi-nuclear cells. What especially characterizes this formation is the circumstance that it is extremely rich in nuclei, so that when it is examined as it lies imbedded in the tissue which invests it, at the first glance there seems to be scarcely any thing else than nuclei. But upon isolating the constituents of the mass, either very small cells provided with one nucleus are obtained—and these are often so small that the membrane closely invests the nucleus—or larger cells with a manifold division of the nuclei, so that from twelve to twenty-four or thirty are contained in one cell, in which case, however, the nuclei are always small, and have a homogeneous and somewhat shining appearance.

"This structure, which in its development is comparatively most nearly related to pus, inasmuch as it has the smallest nuclei, and relatively the smallest cells, is distinguished from all the more highly organized forms of cancer, cancroid, and sarcoma, by the circumstance that these contain large, voluminous, nay, often gigantic corpuscles, with highly developed nuclei and nucleoli. Tubercle, on the contrary is always a pitiful production, a new formation from its very outset miserable. From its very commencement it is, like other new formations, not unfrequently pervaded by vessels, but when it enlarges its many little cells throng so closely together that the vessels gradually become completely impervious, and only the larger ones, which merely traverse the tubercle, remain intact. Generally fatty degeneration sets in very early in the center of the knot (granule) where the oldest cells lie, but usually does not become complete. Then every trace of fluid disappears, the corpuscles begin to shrivel, the center becomes yellow and opaque, and a yellowish spot is seen in the middle of the gray, translucent granule. This is the commencement of the *cheesy metamorphosis* which subsequently characterizes the tubercle. This change advances from cell to cell, further and further outward, and it not unfrequently happens that the whole granule is gradually involved in it.

"Now, the reason why I think that the name of tubercle must be *specially* retained for this formation as being extremely characteristic of it,

but must be burned, or be removed by the excretory organs.

254. I find the proof of this statement in these facts: That the variations of bodily temperature are in these cases extreme and rapid, the thermometer showing an increase of from two to six degrees, where the causes of derangement are but slight, and

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is this—that the tubercle-granule never attains any considerable size, and that a tuber never arises out of it. Those which are wont to be termed large tubercles, and attain the size of a walnut, or a Borsdorf apple, as, for example, in the brain—those are not simple tubercles. You will generally find the tubercles in the brain described as being solitary, but they are not simple bodies; every such mass (tuber) which is as large as an apple, or even not larger than a walnut, contains many thousands of tubercles; it is quite a nest of them which enlarges, not by the growth of the original focus (granule), but rather by the continual formation and adjunction of now foci (granules) at its circumference. If we examine one of these perfectly yellowish-white, dry, cheesy tubera, we find immediately surrounding it a soft, vascular layer, which marks it off from the adjoining cerebral substance—a closely investing areola of connective tissue and vessels. In this layer lie the small, young granules, now in greater, now in less number. They establish themselves externally (to the previously existing ones) and the large tuber grows by the continual apposition of new granules (tubercles), of which every one singly becomes cheesy; the whole mass, therefore, can not in its entirety, be regarded as a simple tubercle. The tubercles themselves remain really minute, or as we are wont to say, *miliary*. Even when on the pleura, by the side of quite small granules, large yellow plates, looking as if they were deposited upon the surface, are met with; these, too, are not simple tubercles, but masses composed of a large aggregate of originally separate granules.

"Here, you see, form and nature are in reality inseparably connected. The form is produced by the growth of the tubercle from single cells of connective tissue, by the degenerative proliferation of single groups of connective tissue corpuscles. Thus, without more ado, it appears at once in the shape of a granule. As soon as it has once attained a certain size, as soon as the generation of new corpuscles which develop themselves out of the old histological elements by a continual succession of divisions at last lie so close to one another as to cause a mutual arrest of development, gradually to induce the disappearance of the vessels of the tubercle, and thereby to cut off their own supplies, then they begin to break up, they die away, and nothing remains behind but debris—shrunken, disintegrated, cheesy material.

"The cheesy transformation is the regular termination of tubercle, but on the one hand, it is not the necessary one, inasmuch as there are rare cases in which tubercles, in consequence of their undergoing a complete fatty metamorphosis, become capable of re-absorption; and on the other hand, the same cheesy metamorphosis befalls other kinds of cellular new formations; for pus may become cheesy, and likewise cancer and sarco-

that in those persons the excretions are in excess, at least during slight disturbances of the functions of the body. Increased activity of the excretory organs, and increased development of heat, I am certain, are characteristic inthese cases.

255. So long as there is nothing to change the uniform methods of life, so long this person enjoys health. In other words, so long as the defective material is not in excess, and so long as the

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ma. This metamorphosis, therefore, being common to more than one formation, can not well be set down as a criterion for the diagnosis of any particular structure, such as tubercle; on the contrary, there are certain stages in its retrograde metamorphosis, where one can not help confessing that it is not always possible to come to a decision. If a lung be laid before you with cheesy masses scattered through it, and you are asked if that be tubercle or no, you will frequently be unable to say with certainty what the individual masses originally were. There are periods in the course of development when that which is inflammatory and that which is tuberculous can with precision be distinguished from one another; but at last there comes a time when both products become confounded, and when, if one does not know how the whole arose, no opinion can any longer be formed as to what its nature is. In the midst of cancerous masses also cheesy spots occur which look exactly like tubercles. I have demonstrated that it is by the gradual transformation of the elements of cancer that this cheesy matter is produced. But if we did not positively know from the history of their development that cancer cells disintegrate step by step, and that no tubercles form in the middle of cancer, we should, in many cases, be altogether unable to arrive at any decision from merely examining the specimen.

"If those difficulties be surmounted, which lie in the external appearance of the formation, and lead the observer astray not only when he considers its grosser features, but also when he investigates its more intimate composition, there remains nothing else to assist us in coming to a right conclusion than the investigation of the type of development displayed by the individual new formations during the stages of their actual development, not during those of their retrograde metamorphosis. The nature of tubercle can not be studied after the period when it becomes cheesy, for from that time its history is identical with the history of pus which is becoming cheesy; an earlier period must be chosen when it is really engaged in proliferation. So in the case of other formations, that period must be studied which is comprised between their origin and their culminating point, and we must see with what normal physiological types they agree. Then it is, I think, certainly possible for us to arrive at a just conclusion with the aid of the simple principles of histological classification which I have already propounded to you. *Heterologous tissues also have physiological types.*"—VIRCHOW, pp. 517-525.

excretory organs and combustion frees the system from it, so long there is no serious disturbance. "Such persons get sick easy and recover quickly. Slight causes of disease have an exaggerated effect, and they are said to be weakly, not rugged, have poor constitutions," etc. I quote the language commonly employed by professional men as well as the people to prove the correctness of my conclusion.

256. After a time, from some disease disturbing the functions of the body or affecting the digestive apparatus, the vitality of the person is still further reduced, and this imperfectly formed material is supplied the blood in larger quantities. If now the excretory organs are inactive, and a febrile process is not set up (for combustion), the result will be an excess of aplastic material in the blood. It may for a time be got rid of by a suppurative skin disease, ulceration, or other suppurative process, as in white swelling; but in the majority of cases it will be thrown out of the blood-vessels as tubercle.

257. Where it will be deposited depends upon local causes. Wherever there is a point of irritation, with determination of blood, the deposit will occur. If the patient has a cold, with irritation of the lungs and cough, it will be as a phthisis pulmonalis; if a bone has been injured, the deposit will be there; if the bowels, we will have it in the mesenteric glands; and if of parts freely supplied with lymphatics, it will be in the neighborhood of lymphatic glands. The reason why tuberculous deposit occurs more frequently in the lungs than other organs is, that irritation of them is far more common.

258. Though there is a striking analogy between scrofula and tuberculosis, we must not regard them as the same. In scrofula the deposits may be either euplastic, cacoplastic, or aplastic, and it is always a vice of nutrition rather than of the blood, as will be explained hereafter. Many persons who have suffered from scrofulous inflammation have lived to a good age, and have enjoyed excellent health. Still, when the deposit is either cacoplastic or aplastic, especially the last, we classifiy the cases with the tuberculoses.

259. When we come to examine tubercular material we find a very wide range of structure, from that presenting a dense resisting mass to a cheesy structure, possessing no trace of form and but little consistence. The higher grades of tubercle show traces of organization. There are nucleated cells and a fibrous arrangement when the deposit is cacoplastic; but when aplastic it has but irregular-shaped bodies, containing from one to half a dozen granules, and no tendency to fibrillation. The quotation I have made from Virchow gives the latest observations on this subject.

260. In tuberculosis the material first deposited is the best, in that it is capable of a slight degree of organization and the power to resist change. But as the deposit continues we find that its organization is lower and lower, until at last it seems to break down, and immediately it is exuded from the vessels. We thus account for the slow progress of tuberculosis in its early stage, and its rapid progress as the patient becomes exhausted.

261. Let us not overlook the fact that tuberculosis is always a lesion of the blood (its albumen), and that the source of this lesion may commonly be traced to the assimilation of chyle. We will hereafter, when examining the blood-making organs, discuss this point again. It is claimed by some that the tuberculous material may have its origin in lymph returned to the blood-vessels through the lymphatic system; but this, also, I think we will show to be untenable.

262. *Treatment.*—If I have correctly described the aplastic deposit, we will have but little difficulty in forming a rational treatment. The origin of the material is in defective assimilation or formation of chyle into blood; and, just in proportion as hygienic measures and remedies will correct this, just in that proportion is the tendency to tuberculosis overcome. If the child born of tuberculous parents is placed in a high and healthy locality, and given active exercise in the open air, and a good nutritious diet, there will be a radical change in the constitution by the time he reaches adult years. This may be aided at

first by the use of bitter tonics, iron, and other restoratives; but these will never take the place of the means above named

263. The young adult having a tendency to phthisis may ward off the attack for many years by adopting the same course. A rational treatment of a tuberculosis at any stage must be based upon the same course, and if recovery is possible, it is possible only in this way.

264. Active open-air exercise stimulates digestion and assimilation, the first requisite, and increases combustion and secretion, the second requisite. I can not see but that this reasoning is correct, for the means named tend to give us a better quantity and quality of blood, and at the same time to remove imperfectly formed material from it. The practice is not only a rational one, but it is a successful one, and, I think, will be employed whereever the pathology of tuberculosis is understood.

265. In considering the remedial means, we may first notice the fact that the employment of tonics and stimulants to the digestive organs is the most injurious plan that can be adopted. It creates a desire for more food than can be digested and made into blood, and the result is the introduction of material that can not be used in nutrition, and must either be burned or carried out by the excretory organs, or deposited as tubercle. Many a person has been hurried out of the world by this common method of treatment.

266. In place of this we think of the means which will aid in burning the aplastic material out of the blood, and those which will fit it for excretion and aid the excretory organs to remove it. Cod-liver oil, the hypophosphites, especially hypophosphite of lime, small doses of arsenic, and sometimes alcoholic stimulants, serve the first purpose. These are assisted by exercise in the open air as above named. The ordinary means for establishing and continuing good secretion, in so far as they can be used, are of advantage. It will be recollected that with a high temperature and frequent pulse all the functions of life are imperfectly performed. Food will be badly digested, blood-making will be imperfect, and secretion and excretion will be impaired. Means

to regulate the temperature and the circulation will therefore be of importance: thus in some cases veratrum and lycopus have been used with marked benefit, and remedies that give strength to the skin are always useful.

MORBID GROWTHS.

267. When we speak of a growth, we understand an organization that, arising from the normal tissues, and receiving its supply of nutrient material from the blood vessels, is developed in different forms from these tissues. These developments differ from hypertrophy, that, though arising from, they are really independent of the normal structures; and though they may grow by similar multiplication of cells, the arrangement of tissue is not in normal order. They are new structures, and have no function in common with the healthy body, and serve no useful purpose in life. Hence they have been termed parasitical, and likened to those vegetable parasites which, having attached their germs to a tree, thrive and flourish on its juices, though the tree may languish from want of them.

268. Most writers have divided these growths into *analogous* and *heterologous*, or those in which the process of growth and the tissue resemble some natural texture, and those which bear no resemblance to any tissue. This classification can not be carried out, because in all growths there is some analogous formation, even the most malignant, while in the *benign* we may have a heterologous development. The most practical classification is *non-malignant* and *malignant* growths, though there is sometimes a difficulty in making the distinction.

269. *Non-malignant Growths.*—A non-malignant growth always has a fibrous basis, and has its origin from connective tissue. The cause is always obscure; but, from what we know of analogous processes, there is some cause of irritation, which excites

the formative activity of the connective tissue, causing a rapid cell-production and formation of analogous tissue.* Such a growth continues its development from its base, and in some instances the new formation goes on from all parts.

270. These non-malignant tumors vary very greatly in size, consistence, and in development, but we may classify them in three divisions. In the first there is not only a new development of tissue, but much of the old connective or mucous tissue is

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* "It is always possible to convince oneself that *what is called a tumor constitutes a conglomerate mass, often extraordinarily large, made up of a number of little miliary foci* (lobules), of which every single one must be referred to a single or a few parent elements. Inasmuch as the formations progress in this manner, no matter whether they consist of pus, tubercle, or cancer, new young zones are being constantly added on to the old ones, and we may, if we intend to trace the course of development, calculate with great certainty upon always finding the young parts at the extreme circumference, the old onés always in the center, *But the zone produced at the latest period of the disease extends to a considerable distance beyond the zone of degeneration, that can be discerned by the naked eye.* If we examine any proliferating tumor of a cellular character, we often find, three to five lines beyond its apparent limits, the tissues already in a state of disease, and exhibiting the first traces of a new zone. This is the chief source of local recurrence after extirpation, for it proceeds from the zone that can not be detected by the naked eye, beginning to grow in consequence of the increased supply of nutritive material, which results from the removal of the original tumor. No new deposit from the blood takes place there, but the new-formed germs, which already lie in the neighboring tissue, run through their further development in the same manner that it would otherwise have taken place, or perhaps even still more quickly.

"This fact I regard as extremely important, because it shows us that all these formations have essentially a *contagious character*. As long as it was imagined that the mass once formed increased only by the growth of its constituents, it would of course look as if all one had to do for the purpose of getting rid of it was merely to cut off from the tumor all further supply of material. But there is manifestly a contagious matter formed in the tumor itself, and when the cells which are in its immediate neighborhood, and are connected by anastomoses with the diseased cells, likewise enter upon the heterologous proliferation, it is impossible, I think, to come to any other conclusion in the matter than that the degeneration of the neighboring parts arises in precisely the same manner as that of the nearest lymphatic glands which lie in the course of the stream of lymph which proceeds from the diseased part. The more anastomoses the parts possess the more readily do they become diseased, and *vice versa*.

drawn into it, and the vessels of this part enlarging, we find the growth freely supplied with blood-vessels. This is the case with mucous polypi, especially those of the nose. In the second the development is cystic, the fibrous tissue forming the containing walls. There is no doubt that in some of these cases, possibly in all, the contained matter, whether it be serous, fatty, cheesy, or what not, is simply formed from the worn-out material of the growth; that is, we may regard its cavity as a cloaca,

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In cartilage malignant affections are so rare that it is usually assumed to be altogether insusceptible of them. Thus in a joint the cartilaginous investment alone is sometimes found intact, while every thing else has been destroyed. Thus, too, we see that fibrous parts, which are rich in elastic elements, are very little disposed to become diseased by contagion. On the other hand, the softer a basis-substance is, and the better the conveyance can take place, the more certainly may we expect that, when occasion offers, new foci of disease will arise in the part. I have therefore come to the conclusion—the only one I think the facts warrant—that the infection is directly transferred by the means of the morbid juices from the original seat of the disease to the anastomosing elements in the neighborhood, *without the intervention of vessels and nerves.* The nerves are indeed often the best conductors for the propagation of contagious new formations, only not as nerves, but as parts, with soft interstitial tissue.

"Here we have the importance of the anastomosing cellular elements of tissues and the value of the cellular theory most clearly exhibited; and when once we have become acquainted with this mode of conduction, we are afterward able, with a certain degree of probability, to foresee in what direction, in parts possessing this means of conveyance, the disease will extend, and where finally the greater or less danger lies. It has hitherto been impossible to prove whether the infection of remote parts is effected by the conveyance of juices, in the same way that the infection of neighboring parts is, and especially whether the blood takes up any thing noxious from the diseased spot and conveys it to a distant place. I must confess that I am acquainted with no sufficiently convincing facts bearing upon the matter, and must still allow it to be possible that the diffusion by means of vessels may depend upon a dissemination of cells from the tumors themselves. There are, however, many facts which speak but little in favor of the infection's taking place by means of really detached cells; for example, the circumstance that certain processes advance in a direction contrary to that of the current of lymph, so that, after a cancer of the breast, disease of the liver takes place, while the lung remains unaffected. Here it seems pretty probable, that juices are taken up, which occasion a further propagation.

"Allow me still to add a few words upon a subject which can here be dispatched off-hand, namely, the so-called *parasitism* of new formations.

which receives its own excretions. In the third, we have the growth wholly of fibrous tissue, possessing neither blood-vessels, nerves, nor contents.

271. The injury done by the non-malignant growth is of two kinds. It diverts the nutritive material from its normal uses, and to this extent impoverishes the body. In the majority of cases this is but slight, and produces no disturbance of the nutritive functions. In the second place, it produces local disturbance by its attachments, by displacing organs and parts, and by pressure. In some cases the continued pressure causes an absorption of the normal tissues to a very great extent, though this is not common.

272. *Treatment.*—In a majority of cases the complete extirpation of the growth is sufficient for a cure. In others there seems to be a tendency to such nutritive derangements, and we find one

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"It is self-evident that the view taken of parasitism by the old writers, who held it to be applicable to a large proportion of new formations, is completely borne out by facts, and that in reality every new formation which contributes to the body no serviceable structures must be regarded as a parasitical element in the body. Only bear in mind that the idea conveyed by parasitism does not differ from that conveyed by the anatomy of every part of the body, excepting in degree, and that every single epithelial and muscular fiber-cell leads a sort of parasitical existence in relation to the rest of the body, just as much as every individual cell in a tree has, in relation to the others, a special existence, appertaining to itself alone, and deprives the remaining cells of certain matters. Parasitism, in a narrower sense of the word, develops itself out of this idea of the independence of individual parts. As long as the requirements of the remaining parts demand the existence of a part, as long as this part is in any way useful to the other parts, so long will it not be termed a parasite; but it becomes so from the moment that it becomes foreign or injurious to the body. The epithet parasitical must, therefore, not be restricted to a single class of tumors, but applies to all heteroplastic forms, which do not in the course of their further metamorphoses give rise to homologous products, but furnish neoplasms which, in a greater or less degree, are alien to the composition of the body. Every one of their elements will withdraw matters from the body which might be used for other purposes; and as it has, at the very outset, destroyed normal parts, and even its first development presupposes the destruction of its parent structures, it both plays a destructive part at the commencement of its career and a depredatory one throughout its course.—*Virchow*, pp. 502–506.

growth after another springing up, but without any connection between them. In a third class of cases the growth is continually reproduced after removal—*recurring fibroid tumors;* and in some cases these seem to degenerate into malignancy.

273. In the removal of all these growths, it is essential that the base or tissue from which the morbid process has arisen should also be excised or destroyed. If not, there is no reason why the most benign of these tumors should not be reproduced. But with the recurring fibroid tumor, some cystic tumors, and polypi, especially of the nose, the tendency to reproduction is so great that special care in this regard is necessary. In my practice, after their removal, I establish free suppuration from the base, and heal by granulation. Any person may test this treatment on those epithelial growths of the hands—warts. They can not be extirpated with the knife so but what they will recur, but if a process of suppuration is established and continued in one its death is certain, and it is not reproduced.

274. Prof. Howe claims that the growth is in concentric layers from the center, and if this center be destroyed by any means, the further growth will be arrested, and in many cases the tumor will be partially or wholly absorbed. Thus, when these growths can not be removed, as in the case of interstitial uterine fibroids, he injects tincture iodine through a needle made for this purpose into the center of this growth, through the vagina and sometimes through the uterine cavity. Electro-puncture has been employed for the same purpose, the needles being passed deeply into the growth, and a constant current battery of several elements being attached.

275. *Malignant Growths.*—It has been claimed by many writers that a growth was malignant when formed of *heterologous* tissue, *benign* when formed of *analogous* tissue, and we have been treated to long disquisitions as to the different forms assumed by malignant cells, with plates and wood-cuts, making a tangible exhibition of such difference. This has been taught so long, by so many, and with such pertinacity, that the majority of physicians hold it

as an established fact, and, if they were about to make a microscopical examination, would expect to find as much difference between cancer cells and others, as they would between a gourd and a grain of wheat. The contortions of these cells, "elongated, fusiform, big-bellied, with absurd prolongations, nuclei, nucleoli," etc., is taken as an established fact.

276. I would not expect any one to take my word for it that this is a fable, and that we may or may not find such cells in cancer, and that whether we do or do not find them in a growth, has but little bearing on the diagnosis. I will therefore give authority, and that from that most phlegmatic and unideal of all Germans, Virchow,* and I hope the reader will give the quotation a careful perusal.

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*"So, moreover, we find among pathological new formations a large category, the natural type of which is epithelium—*epitheliomata*, if you will. But the term epithelioma, which has recently been introduced by Hannover, is completely inadmissible in the case of the particular kind of tumor which it was intended to designate, because the epithelioma is by no means the only tumor whose elements bear the character of epithelial cells. Epithelioma can not be distinguished from other tumors by its elements having the character of epithelium, while those of the others have it not. The tumor that (Johannes) Miller called cholesteatoma, Cruveilhier *tumeur perlee*—which I have translated *perlgeschwulst* (pearly tumor)—this tumor has exactly the same epithelial structure as that which Hannover has called epithelioma; nay, ordinary epithelioma very commonly engenders in itself little pearly globules in an often astonishingly great number. Yet both exhibit very essential points of difference. Never as yet have any pearly tumors been seen which, after existing in one place, recurred in remote places, and behaved like malignant tumors; never did any thing else occur than a slight extension—and that at an extremely slow rate—to the immediate neighborhood of the tumor. In the case of epitheliomata, on the other hand, or as they are otherwise called, epithelial cancer or cancroid, we see a very marked malignity, for not only are they liable to recur at their original site, but they also reproduce themselves in distant parts. In many cases nearly all the organs of the body are metastatically filled with masses of cancroid.

"Again, if you attempt to distinguish cancroid growths from real cancer by the epithelial structure of their elements, you will herein, too, give yourselves trouble in vain. Cancer proper has also elements of an epithelial character, and you need only to turn to those parts of the body where the epithelial cells are irregularly developed, as, for example, in the urinary passages, and you will meet with the same curious bodies, provided with large nuclei and nucleoli, which are described as the

277. I made my first microscopic examination for cancer cells on a growth that was most malignant, and which destroyed the patient in about fourteen months from its commencement. There was not a single cell found resembling those figured as cancer cells, in a protracted examination of portions taken from different parts of the mass. I have made these examinations frequently, and in most cases have found peculiarly-formed cells associated with those of normal structure. But I have found the same cells in other growths, and occasionally a production from the normal tissues. The most marked example of these forms I ever saw was from an epithelial growth of the lip, which disappeared of itself, and has not been reproduced though some eighteen years have passed. If any person desires to test this, let him take portions of condylomata from the vagina or under the prepuce of the male, and he will be likely to find many specimens that he has seen figured as cancer cells.

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specific, polymorphous cells of cancer. Cancer, cancroid or epithelioma, pearly tumors or cholesteatoma, nay, perhaps the dermoid growths which produce hairs, teeth, and sebaceous glands, and so frequently occur in the ovary—all these are formations in which there is a pathological production of epithelial cells, but they constitute a graduated series of different kinds, which extend from those which are entirely local, and, in the usual meaning of the word, perfectly benignant, to the extremest malignity. The mere form of the cells which compose a structure is of no decisive value. Cancer is not malignant because it contains heterologous cells, nor cancroid benignant because its cells are homologous—they are both malignant, and their malignity only differs in degree.

"The forms which yield dry, juiceless masses are relatively benignant. Those which produce succulent tissues have always more or less a malignant character. The pearly tumor, for example, yields perfectly dry epithelial masses, almost without a trace of moisture, and it only infects locally. Cancroid remains for a very long time local, so that the nearest lymphatic glands often do not become affected till after the lapse of years, and then again the process is for a long time confined to the disease of the lymphatic glands, so that a general outbreak of the disease in all parts of the body does not take place until late, and only in rare instances. In cancer proper the local progress is often very rapid, and the disease early becomes general; a cure, even for a short time, is so rare, that in France the complete incurability of cancer, properly so called, has been asserted and maintained with success.

"Among the formations also which are analogous to the ordinary connective tissues, and are therefore apparently perfectly homologous and

278. What, then, you may reasonably ask, is it that renders cancer so destructive, and in what does it differ from benign growths? These questions can not be satisfactorily answered with our present knowledge. We know that malignant growths have great vital tenacity and great reproductive power, but from whence this power or tenacity can not be explained. What we do know of them is comprised in their natural history, and is a matter of observation.

279. These malignant growths may be classified in three varieties, though they are not always distinct. There are the *epithelial*, *scirrhous*, and *medullary*, and are malignant in the order in which they are named.

280. *Epithelial Cancer*, also called *cancroid*, has its origin in the skin or mucous membrance, and its cause in some abnormality of the epithelial cells. I believe that it is now generally ad-

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benignant, the succulent ones prove to be much more capable of communicating infection than the dry ones. A myxoma which has always a good deal of juice about it, is at all times a suspicious tumor, and, in proportion to the quantity of juice it contains, is its liability to recur. Cartilaginous tumors (enchondromata), which were formerly described as unquestionably benignant, sometimes occur in soft and rather gelatinous forms, which may occasion just such internal metastases as cancer properly so called. Even connective tissue (fibrous) tumors become, under certain circumstances, richer in cells, and enlarge, while their interstitial connective tissue becomes more succulent, nay, in many cases disappears so completely that at last scarcely any thing but cellular elements remain. This is the kind of tumor which, in my opinion, ought to be designated by the old name of *sarcoma*. These sarcomata are frequently indeed benignant; still they do not unfrequently recur, like epithelial cancer, at their original site, while under certain circumstances they appear secondary in the lymphatic glands, and in many cases occur throughout the whole body metastatically to such an extent that scarcely any organ is spared by them.

"In the case of all these formations, every one of which corresponds more or less completely to a normal tissue, investigations ought not to be conducted with a view to determine whether they have a physiological type, or whether they bear a specific stamp impressed upon them; our final decision depends upon the answer to the question, *whether they arise at a spot to which they belong or not, and whether they produce a fluid which, when brought into contact with the neighboring parts, may there exercise an unfavorable, contagious, or irritative influence*."—VIRCHOW, pp. 527–532.

mitted that this disease arises from an irritation or injury, such as would at any time cause a change or increase in cell production. Many cases of epithelial cancer of the lip clearly have their origin in the continued irritation of the pipe, of the tongue, in an irritation from decayed teeth, etc. It is true that in some cases we can not find an adequate cause, but we should not therefore disregard these facts.

281. There is no doubt but that epithelial cancer is at first strictly a local disease, and though it manifests such strong tendency to recur in its original situation, yet it may be entirely removed. But as the growth increases, and involves adjacent parts, we find the lymphatic glands nearest becoming affected first, and after a longer or shorter period of time a cancerous cachexia is developed—in other words, the disease becomes constitutional, and not susceptible of cure.

282. If we examine this growth, we will find the type of the development is epithelial, and its appearance is thus described by Paget: "The surface of a vertical section through such a cancer commonly presents at its upper border either a crust or scab, formed of ichor, detached scales, and blood; or else a layer of detached epidermoid scales, forming a white, crumbling, pasty substance. This layer may be imperceptible or extremely thin; but it may be a line or more in thickness; and it enters all the inequalities of the surface on which it lies. Its cells or scales are irregular, tesselated or imbricated, like those of the epidermis on a common wart, but are placed without order, loosely connected both with one another and with the subjacent vascular structures, and may be easily washed away."

283. The substance of the growth is firm and close-textured, of a grayish or grayish-white color, and contains some fatty bodies, and occasionally structures resembling hair follicles. If pressed or scraped, it yields a turbid yellowish or grayish fluid, and sometimes a thicker curdy substance. At first confined strictly to the skin and mucous membranes and their connective tissue, it seems to gain malignancy with age, and at last passes to

the deep-seated tissues, muscles and bones, and becomes as destructive as either of the other varieties.

284. *Scirrhus*, or hard cancer, is the most common form of malignant growth. At first, if developed in connective tissue, it seems almost entirely distinct from the structures where it arises, having attachments at but few points. While small, it can be readily enucleated like a fibroid growth, though it will reappear again unless its base is entirely destroyed. When it arises in the mammary glands it still seems distinct, as it is readily movable under the skin, yet when we come to examine it closely, we find it formed by a deposit of cancerous tissue in the normal tissues of the part. This is also the case when occurring in other structures, especially in the skin.

285. If we examine the structure of this growth we will find it to consist of three parts: 1. Of the fibrous and glandular structures of the part in which it arises, and which, as it grows, it takes possession of. 2. Of certain cells and corpuscles, sometimes observing an obscure fibrillation. 3. Of a fluid, semi-fluid, and solid blastema, in which all the preceding seem to be imbedded. The growth of a hard cancer is by additions to its surfaces, and not by internal increase, and in this growth it takes possession of the normal tissues, their blood-vessels, cells, and nutritive material, so that in some cases it would seem more like a degeneration than a growth. Of course this growth is variable, in most cases slow; it sometimes becomes quite rapid, and not unfrequently has its periods when it but slowly increases in size, and others in which its growth is rapid.

286. The fact that it employs the original tissues is clearly seen when we trace the progress of the growth from the skin through the muscles to the bones, involving each of those parts in a common ruin. In its progress the cancerous material can be detected *in* the skin, muscle, and bone, while it is still skin, muscle, and bone.

287. Sooner or later the tissue of which the cancer is formed dies, as it is susceptible to change, like the normal tissues of the

body, and a process of ulceration is set up, causing open cancer. There is no doubt but that there is continued metamorphosis of cancerous tissue, as of the normal tissues, and the reason why they are less hard and possess more fluid elements as they advance in age, is because of this—the worn-out materials are excreted into their own structure.

288. I believe that scirrhus, like the epithelial cancer, is at first strictly a local disease, but it much sooner infects the general system. There is undoubtedly a *constitutional vice* that favors these malignant growths, and it may be so strong that they will arise from the slightest causes. In such cases, of course, there is no cure, but in others, in the early stage of the disease, the growth may be entirely removed, and its tendency to recurrence overcome.

289. *Medullary Cancer.*—These are the most malignant of the group, not only as to the rapidity of their growth, and the local destruction of tissue, but also the rapidity with which they infect the system. Indeed, in some cases it seems that from the first the disease is constitutional. Mr. Paget remarks "that the boundaries of the group of medullary cancers can be only vaguely drawn; for though on the whole, and as a group, they have peculiarities both of structure and of history, which sufficiently distinguish them from the scirrhus and other cancers, yet, define them by whatever characters we may, a series of specimens might be found filling every grade between them and each of the other chief forms. The term 'soft cancer,' often applied to them, expresses their most obvious, though not their most important, distinction from the scirrhus or hard cancers. They may be divided into *soft* and *firm* medullary cancers, and in any large number of specimens the softer kinds would constitute about two-thirds, the firmer about one-third, of the whole number. The former would include such as are described as encephaloid, brain-like, pulpy, placental, etc.; the latter would be such as have been called mastoid, solanoid, nephroid, apinoid, etc."

290. We have not as yet a definite description of the struc-

ture of medullary cancer, at least not one on which writers agree. So far as my examinations have extended, and comparing them with the observations of late writers, I would describe it as follows: The connective tissues of the part are always taken possession of by the malignant growth, and are not absorbed and removed as generally supposed. With these connective tissues remain, the arteries and veins, the lymphatics and nerves. Thus the basis of the growth is the fibrous tissue of the part, its plasma is supplied by the vessels of the part, and it is sensitive by the nerves of the part being entangled within it. All other tissue, muscular, glandular, nervous, and osseous, is absorbed, and in its place is deposited the cells of the growth surrounded by a stroma giving no trace of organization.

291. This growth may arise at any point, as all tissues possess the elements it requires, fibrous tissue for support, and a supply of blood. It is soft, succulent, and rapid in growth in proportion to the development of the blood-vessels that supply it, and the various kinds of fluid and semifluid matters found in it are almost in exact proportion to its rapidity of growth and metamorphosis. For, like some other growths, its excretions are deposited in its own structure.

292. When this variety ulcerates the destructive process is very rapid, as in these excreta are the elements of a rapid breaking down. And as the tissue is thus rapidly destroyed, the blood-vessels are eroded, giving rise to the profuse hemorrhage so common in this variety. With the commencement of the process of breaking down, there is in many cases a more rapid growth of the cancerous tissue, or, as it were, an infiltration of adjacent parts, and the disease passes rapidly to a fatal termination.

293. *Constitutional Infection.*—That there is a period in the history of malignant growths when they are strictly local is admitted, I believe, by the best observers, and that after a certain period there is a constitutional infection is equally true. We are especially interested in determining the period when cancer is confined to the growth, as up to this time it is susceptible of cure.

294. I recognize a *vice* of constitution, or more properly speaking, of *formative power* (197), in some cases of malignant growths, in which the constitutional disease is first, or at least simultaneous, with the local. In other cases, weeks, months, or years pass before there is constitutional infection, but it comes at some time in all cases, if the local disease is allowed to progress. We have already seen that it was less rapid in epithelial cancers, varying very greatly in scirrhus, sometimes very long, at others short, and always rapid in the medullary growths.

295. How this constitutional infection takes place is an important inquiry, as, if this be determined, we may in the future find means to retard, if not prevent it. It has been supposed by many writers that the cancer cells were taken up by the lymphatics, and by them conveyed through the thoracic duct into the current of blood. In olden times it was thought they gained entrance directly into the veins by absorption. Following the proof that nothing preserving *size* and *form* can be absorbed by the veins, comes the proof that nothing possessing size and form can gain entrance to the circulation through the lymphatics; for, as will be shown when we consider the pathology of the lymphatic system, there is no direct passage though the lymphatic glands by continuous vessels, but an entire break, by interposition of a distinct structure. It follows that cancer cells can not gain entrance to the circulation through this channel.

296. But may they not gain entrance by cancerous erosion of veins, or degeneration of veins. I judge not from these reasons, namely, that we do not find the secondary growths in the lungs, liver, or articulations, where such cells would most likely be deposited. Neither do we find that secondary cancerous growths are common in the stage of constitutional infection, and therefore there is no need of Virchow's theory of a contagious fluid or plasma, though a new growth might be developed in this way.

297. What, then, is this constitutional infection? There is a tendency to degeneration of tissue not necessarily cancerous. The "bioplasm," or material of growth, is changed by the malignant disease, and whether it is that outside of the cells ("cancer

juice"), or whether it is that set free by the rupture of cancer cells, it is capable of absorption, and of being carried by the current of blood to any part of the body. I conclude that it is more likely material set free by the rupture of cells, and the first infection of lymphatic glands nearest the part is by the lymphatic absorption of this cancerous biop'asm. I have mentioned that such conditions might precede or attend the cancerous growth, and it almost invariably follows it. The causes leading to this general cachexia may be the derangement of the nutritive fluids to supply the parasitic structures, the nervous depression incident to it, but especially the excreta of such growth thrown into the blood-vessels to a greater or less extent.

298. *Treatment*—It is claimed by a majority of the surgical authorities that cancer is incurable, by *cancer specialists* that it is curable. The weight of authority is in favor of the first view, and its supporters are reputable and evidently sincere, while many of those who contend for its curability, are neither reputable or sincere. But if, as I have shown, the disease is for a time *local*, it may up to that time be removed, as any other local affection. But when the constitutional vice is once established there is no cure, as we have not yet discovered any means of reaching the constitutional disease.

299. Cancerous growths are curable, then, in their earlier stages —the epithelial most, scirrhous next, and the medullary least. It is impossible to determine, in many cases, when the dividing line of curability is passed; but admitting my premises, it will be seen that the earlier the treatment the stronger the probabilities of success.

300. The general treatment of cancerous disease is not unimportant; indeed, in many cases it is of first importance, for this constitutional infection is slowly established and commences early. The means recommended in cases of degeneration (215) and in cacoplastic deposits (249) are those I deem applicable here. It consists essentially in the employment of the bitter tonics and restoratives to improve the appetite, digestion and assimilation,

and thus improve the quantity and quality of the blood. Out-door exercise and a good nutritious diet, in which animal food preponderates, are the accessories to this. The second part, to provide for the speedy removal of broken down tissue by the skin, kidneys, and bowels, is of equal importance; and in some cases where retrograde metamorphosis seems tardy, means to increase this is of marked advantage.

301. Of course the *local treatment*, or that for the removal of the cancerous growth, is most important, and it is in this that we so commonly find a failure. It is only in rare cases that excision is sufficient, for cancer infiltrates adjacent tissue; indeed, it grows in this way, and is thus rarely confined to what seems to be a tumor.

302. We now know of two methods that are better than this, though the agents are not as perfect as we desire. In the one the tissue is broken down by softening, and the base from which the growth springs, as well as the infiltrated tissue not yet transformed, destroyed by suppuration. In the other, the vitality of the cancerous growth is destroyed, the mass desiccates, and is at last removed by a suppuration which cuts it off from the sound tissues. The first is accomplished with the most certainty by the chloride of zinc, the usual method of employing it being in a paste, with hydrastis or sanguinaria. The second is only accomplished, so far as we know, by the use of arsenic, and it is generally guarded to some extent by admixture with iron.

303. There is one point in both of these plans that can not be overlooked with safety, and that is the destruction of the material infiltrated into the tissues by the suppurative process. I have no doubt that cancerous elements are removed by suppuration; but if a theory, it is one supported by the experience of all who have accomplished anything in the treatment of these growths. If a cancerous growth is removed with the knife, a cure may be effected by leaving an open wound, and keeping up free suppuration until healed.

304. In using chloride of zinc for the destruction of the cancerous growth, it should be recollected that the more rapid its

escharotic action the better the chances for success. Making a paste of chloride of zinc and gum Arabic in equal quantities, with a small portion of sanguinaria, brought to the requisite consistence by the addition of water, we crowd it into the open ulcer as freely and as far as we can, and repeat it from day to day, until the destruction is complete. In some cases incisions are made with the scalpel, and the paste crowded into them, or pledgets of lint, wetted with the zinc, are used instead. In others still the chloride of zinc is injected into the growth with the hypodermic syringe.

305. In using arsenic, we prepare first a vehicle of hydrated sesqui-oxide of iron, by throwing it upon a paper filter until it attains the necessary consistence. A small portion of lard or simple cerate may then be added. To this we add arsenious acid in the proportion of ʒij. to ℥iv to ℥j. to ʒiij. The first is almost painless, and is called the painless cure of cancer ; the second of course excites irritation and is painful. It is applied to open cancer, or if not yet open the skin is removed by other means, and it is then continually applied until the life of the growth is entirely destroyed, and it is detached by suppuration. In this case the process of healing may either be by suppuration, or may be dry ; in the latter case the part is dressed with a dry sulphate of iron.

306. In some cases of epithelial cancer, the establishment of suppuration by the irritating plaster will be found a good means of cure. These are incipient cases. A better treatment when the growth is somewhat advanced is the free application of carbolic acid, full strength. The carbolic acid is rendered fluid by setting the bottle in hot water, and then it is applied with a camel's hair brush, working it down into the substance of the growth. Suppuration is the result of this application. In still other cases we find a saturated solution of iodine in alcohol (98°) applied with a camel's hair brush, is a good treatment. In this case the cells are desiccated, and their growth and ability to propagate their species destroyed. The same results may sometimes be obtained by the use of a saturated solution of tannic acid in glycerine. This is especially to be commended when the cancer-

ous growth is of that character that a cure is impossible, as it arrests the progress of growth, and is anæsthetic.

307. In cancerous disease of the vagina or uterus, carbolic acid is used with marked benefit, both to arrest the progress of the growth and to relieve the pain. In some cases it is employed of full strength, but in others it is diluted with glycerine, the rule being to give it of that strength which gives the greatest relief to the suffering.

308. It is a question whether there may not be some specific remedy for this change in "bioplasm" which renders it so destructive, and it is my opinion that sooner or later a remedy of this kind may be found. Our Homœopathic friends claim to have cured cancer with hydrastis, and my experience with it has been so favorable that I would recommend its trial. I use the phosphate of hydrastia, one-fourth grain three times a day, and a weak solution of the same as a dressing to the part.

CHAPTER IV.

SECRETION.

309. NATURALLY connected with nutrition and its lesions, as being effected by similar cell-growths, and governed by similar laws, is secretion and its lesions. We will find here as in that which has gone before, some things beyond the range of our physical and mental vision, but I hope we will be able to trace the existence of certain general laws in health and disease, and deduce from them a rational therapeutics.

310. Our first inquiry here is with the apparatus that effects secretion, for in its form and ultimate development we will find the answer to certain important questions. The entire secreting apparatus of the animal body is built upon a single plan, and that very simple, viz., a capillary duct terminating in a *cul-de-sac*, or loop, upon which there is a very free distribution of capillary blood-vessels. If we examine such duct with the microscope, we will find its internal surface studded with a multitude of cells in every stage of development, from the rudimentary to that completely filled and in the act of being disrupted. These are reproduced with the greatest rapidity while the organ is in a healthy condition, and filling themselves from the blood-vessels, they are discharged into the common duct. It is in these cells, then, that we are to look for the function of secretion, as it was in the formative cells that we observed the function of nutrition.

311. We can not detect any difference between the cells of one or another secreting organ, even with the highest magnifying

power, neither can we see any thing in their shape or relation that explains their peculiar function. We know the fact that these cells do abstract from the blood the materials of their peculiar secretion, and must be content to describe it, as does Virchow,* as a *special elective affinity*. It is true that this explains

* "On the other hand, we see that certain materials have some special relation to definite secreting organs; that they penetrate and pervade them by a kind of elective affinity; that they are excreted by them; and that, when there is a too abundant supply of such materials, a state of irritation is produced in these organs. But an essential condition in all these cases is, that the parts which are believed to have a particular elective affinity for particular matters, should really exist, for a kidney which loses its epithelium is thereby deprived of its secreting power. Another condition is that the parts should possess a relation of affinity, for neither a diseased nor a dead kidney has any longer the affinity for particular substances which the gland, when living and healthy, possessed. The power of attracting and transforming definite substances can be maintained at most for a short time in an organ which no longer continues in a really living condition. We are therefore, in the end, always compelled to regard the individual elements as the active agents in these attractions. An hepatic cell can attract certain substances from the blood which flows through the nearest capillary vessel, but it must in the first place exist, and in the next be in the enjoyment of its special properties, in order to exercise this attraction. If the living element become altered, if a disease set in which causes changes in its molecular, physical, or chemical peculiarities, then its power of exercising this special attraction will at the same time also be impaired.

"Let us consider this example with still greater attention. The hepatic cells are almost in direct contact with the walls of the capillaries, from which they are only separated by a thin layer of delicate connective tissue. If now we were to imagine that the peculiar property possessed by the liver of secreting bile, merely consisted in a particular disposition of the vessels of the organs, we should, indeed, in no wise be justified in doing so. Similiar net-works of vessels, in a great measure of a venous nature, are found in several other places; for example, in the lungs. But the peculiarity of the secretion of bile manifestly depends upon the liver-cells, and only so long as the blood flows past the neighborhood of the hepatic cells does the particular attraction of matter continue which characterizes the action of the liver.

"When the blood contains free fat, we see that after a time the hepatic cells take it up in minute particles, and that if the supply continues, the fat becomes more abundant, and is gradually separated in the form of largish drops within the hepatic cells. That which we see in the case of fat in a more palpable form, we must conceive to occur in the case of many other substances in a state of more minute division. Thus for the due performance of secretion it will always be essential that the cells exist in a certain, special condition; if they become diseased, if a condition be developed in them connected with some important chemical change in

nothing, but it locates the process, and places it under that force which we have denominated formative, and classes the act of secretion with that of nutrition.

312. We are interested in knowing that secretion is a vital process, and requires a peculiar organization which is destroyed

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their contents, for example, an atrophy causing the destruction of the parts, then the power possessed by the organ of forming bile will at the same time continually become more limited. We cannot conceive a liver without liver-cells; they are, as far as we know, the really active elements; since even in cases in which the supply of blood has become limited, owing to obstruction in the portal vein, the hepatic cells are able to produce bile, although perhaps not in the same quantity.

"This fact derives peculiar value from its occurrence in the liver, because the matters which constitute the bile do not, as is well known, exist pre-formed in the blood, and we must therefore suppose the constituents of the bile to arise not by a process of simple secretion, but by one of actual formation in the liver. This question has, as you are aware, recently become invested with a still greater degree of interest in consequence of the observation of Bernard that the property of producing sugar is also inherent in these elements, whereby the blood is supplied upon so gigantic a scale with a substance which has the most decided influence upon the internal metamorphic processes and upon the production of heat. If, therefore, we speak of the liver, we can, both in regard to the formation of sugar and that of bile, mean nothing but the action of its individual elements (cells), an action which consists in their attracting matters from the passing current of blood, in their effecting within their cavity a transmutation of these matters, and returning them in this transmuted form either to the blood, or yielding them up to the bile-ducts in the shape of bile.

"Now I demand for cellular pathology nothing more than that this view, which must be admitted to be true in the case of the large secreting organs, be extended also to the smaller organs and smaller elements; and that, for example, an epidermis-cell, a lens-fiber, or a cartilage-cell be, to a certain extent, admitted to possess the power of deriving from the vessels nearest to them (not always indeed directly, but often by transmission from a distance), in accordance with their several special requirements certain quantities of material; and again that, after they have taken this material up, they be held to be capable of subjecting it to further changes within themselves, and this in such a manner that they either derive therefrom new matter for their own development; or that the substances accumulate in their interior, without their reaping any immediate benefit from it: or finally that, after this inhibition of material, even decay may arise in their structure, and their dissolution ensue. At all events it seems necessary to me that great prominence should be assigned to this *specific action of the elements of tissues*, in opposition to the specific action of the vessels, and that in studying local processes we should principally devote ourselves to the investigation of processes of this nature."—*Virchow*, pp. 158–161.

in the act, and not, as some have supposed, a simple process of straining. As a vital act, it requires a continued exertion of formative power for its continuance, and it will be modified or arrested by all agencies that exhaust this power of a part.

313. A gland, as we view it, is an association of such ducts and blood-vessels, bound together by connective tissue. It may seem to differ in its ultimate arrangement and structure, as in the case of the liver and kidneys, but upon close analysis will be found to correspond to the common type.

314. Its function is dependent upon—1, A normal activity in the formation of secreting cells ; 2, A free supply of blood ; 3, That this blood contains the elements of the secretion in such form that they can be used ; and 4, That it has normal innervation. Therefore an increase, defect, or perversion in these conditions, will give increase, defect, or perversion of secretion.

315. Secretion may be divided into two principal kinds, *recrementitious* and *excrementitious* ; the first being a material removed from the blood to perform some function in the processes of the body ; while the second is an entire removal of the material from the body. The material employed in the formation of these secretions is different in the two cases. In the first, it is principally furnished from the digestive organs, and is new material. In the second, it is principally the waste or effete matter of the system, produced by the metamorphosis of tissue. We have the proof of this in the secretion of mucus, one of the recrementitious secretions, which to some extent resembles the epithelial tissue in formation, and bears a close analogy to pus, though of higher organization.

RECREMENTITIOUS SECRETIONS.

316. The principal recrementitious secretions are those of the digestive apparatus—saliva, gastric juice, pancreatic fluid, bile, and fluid from the intestinal glandulæ, of mucous and sebaceous matter, and of the spermatic fluid. We estimate the disease of this

function by the same standard we measure other diseased action, as an excess, defect, or perversion.

317. An *excess* of any of these secretions causes debility just in proportion to its quantity, for the plastic material of the blood is drawn upon for their formation. We also find that the function of parts is impaired, as of respiration, when there is increased bronchial mucus; of digestion, if there is increased salivary, gastric, or hepatic secretion. We also find that the vitality of the part is impaired by the long continuance of such excess.

318. If these secretions are *defective*, the material of which they should be formed is retained in the blood, and to some extent is a cause of disease, as in the case of secretion of bile. But the principal lesion is an imperfect performance of those functions to which these fluids are necessary; as, for instance, in the case of saliva, gastric juice, pancreatic fluid, etc., the defect causes tardy and imperfect digestion; and in the mucous tissues, they are left unprotected, and hence become dry, irritable, and interfere with the function of the organs or part with which they are connected.

319. *Perversion* of these secretions is frequently met with, and occasionally becomes a prominent element in disease. As examples of this, we have changes in the gastric fluid in which it becomes excessively acid, acrid, has the elements of decomposition in an emiment degree, or is changed by a deficiency of its normal constituents. We observe that the bile becomes acrid and irritating at times; at others it has lost some of its elements, and its function in the economy is not performed.

320. *Treatment.*—Recognizing the character of the lesion, the treatment is usually plain and comparatively easy. We have remedies that exercise an influence upon every one of these organs, sometimes direct or special, in other cases indirect. But if we are to use them to advantage we must not forget the *vital* character of the action, which is always to be conserved and strengthened. The remedies are selected with reference to the function of secretion, whether in excess, defect, or perversion;

in the first instance, employing those that lessen excitation of the part and secretion (but not necessarily those that cause debility or loss of vitality). In the second case, those that increase the functional activity of the part, and at the same time conserve and increase its vital power. And in the third case, those agents that restore the normal conditions for proper secretion, and effect such changes in it as will bring it back to a normal standard.

EXCREMENTITIOUS SECRETIONS.

321. There are four principal emunctories by which the system removes its waste of effete material. These are, the lungs for the excretion of the greater portion of the carbon, and the skin, kidneys, and bowels for the nitrogenized waste. The first is one of those perfect functions that is conducted with such certainty, and is so essential to the continuance of life, that physicians have never attempted to interfere with it. The function of the skin, kidneys, and bowels, is indispensable in the continuance of life, and hence deserves very careful study. Excretion of carbonic acid by the lungs is a physical process; excretion by the three other outlets is as purely a vital process as the formation of tissue.

322. *Excretion by the Lungs.*—I propose, first, to discuss excretion by the lungs, as I believe this may be so influenced in some cases as to be an important means of cure. The average amount of carbon removed by the lungs each twenty-four hours is estimated at eight ounces. It is observed to vary with external circumstances, especially with the temperature of the air. Thus it is stated that there is twice as much liberated at 68° as at 106°; the colder the weather the greater the amount of carbon; the warmer the weather the less the amount. This amount represents the quantity of oxygen consumed, the amount of heat generated, and, deducting the purely combustible materials burned,

to a certain extent the waste of tissue; for we are instructed that the breaking down of tissue is due to its oxygenation. This is not to be taken as the whole truth, for a small portion of the carbon is removed by the other excretory organs, in combination with the nitrogen.

323. If oxygenation is important in the breaking down of tissue, and if the lungs remove so large a quantity as eight ounces of solid matter daily, we may well inquire if this process can not, at least to a limited extent, be controlled. We have already referred to this while considering the production of heat (45, 46). There are cases in which the body is enfeebled and its processes sluggish, because it is burdened with an excess of carbon in the blood from defect of respiration. There are cases in which tissue-change is slow, and the worn-out effete material remains in its place, preventing the formation of new tissue; and this in consequence of defective respiratory action, a deficiency of oxygen.

324. It is in these cases especially that I desire to call attention to the lesion of the respiratory function, as I believe the treatment of such cases can be aided by certain measures to increase it. If you have ever witnessed the recovery of a patient from drowning, by Marshall Hall's method, you will better appreciate this subject. The mechanical inflation of the lungs slowly frees the blood from the excess of carbon, and you notice the duskiness of the surface and lividity of the lips gradually passing off. This is the acute case, and is the proof of what may be accomplished by increasing the respiratory act. The exercise that is recommended in such cases as I have mentioned, is more beneficial by increasing the respiratory function than in any other way. Simple leg exercise never answers, unless it is brisk walking in the open air.

325. Surf-bathing is beneficial, in consequence of the vigorous movements of the arms, the full inspirations, and the stimulating influence of sea-air in this direction. Dumb-bell exercise, is an excellent means of increasing the respiratory function, as is the use of the ax or wood-saw, if we wish to utilize this exercise. Simple inflation of the chest three or four times a day,

accompanied by a thorough exercise of the arms and external inspiratory muscles, is of very great benefit, and, if continued, will finally lead to a deep and free respiration.

326. I know by observation that by the methods named the respiratory function can be increased, not simply to the extent of drawing in and blowing out a greater amount of air, but increasing oxygenation and freeing the blood from carbonic-acid gas. There are certain remedies that also increase the respiratory function, and these may be employed, but the well-regulated exercise of the lungs is of the greatest importance.

327. We have seen that the amount of carbon excreted was in proportion to the external temperature, and we have here a fact that may sometimes aid us in therapeutics. A gross man, who is burdened with effete tissues, should have exercise in a low temperature, and never rest in a high one, as is so frequently the case; while, on the contrary, in such cases as presented excessive oxygenation and waste, the patient should be kept quiet in an elevated temperature.

328. *Excretion by the Skin.*—The skin possesses two important functions, one of excretion and one of refrigeration, or heat abstraction by the evaporation of water. The first of these is provided for by a special apparatus—the sudoriparous glands, of which there are as many as three thousand five hundred and twenty-eight in each square inch of surface, or a total of seven millions in a man of ordinary stature, giving a length of perspiratory tubing of about twenty-eight miles. Through this immense system of drainage is daily removed one hundred grains of organic matter, "the larger proportion of which appears to be a protein compound in a state of incipient decomposition;" besides a varying amount of water, containing a small proportion of the salts of the blood.

329. We get a pretty distinct, though rough, idea of the character of this excretion by coming in contact with the unwashed, and by its offensive character in certain portions of the body—the *axillæ*, feet, etc. It is the *waste* of tissue, and it is that waste in

a state of decomposition, as we have noticed above. That it is toxic in its influence upon living matter is proven by the effects observed to follow its retention.

330. Dr. Carpenter remarks that, from the observations of Dr. Fourcault, "it appears that complete suppression of the perspiration in animals, by means of a varnish applied over the skin, gave rise to imperfect arterialization of the blood, and considerable fall of temperature, and which, as it produces death in the lower animals, would probably do the same in man. A partial suppression by the same means gives rise to febrile symptoms, and to albuminuria. There can be no doubt whatever that imperfect action of the cutaneous glandulæ, consequent upon inactive habits of life and want of ablution, is a very frequent source of disorder of the general system, occasioning the accumulation of that decomposing organic matter in the blood which it is the special office of these glandulæ to eliminate. Hence, the maintenance of health requires that this excretion should be promoted by the use of the natural means just referred to; and this is the more necessary when, from any cause, the function of the kidneys is imperfectly performed. There are many diseased states, moreover, in which there appears to be a special determination of the *materies morbi* to the skin, and in which, therefore, the use of means that promote the cutaneous excretion constitutes the most efficient means of eliminating them from the blood."

331. *Increase* of this excretion as an element of disease always causes debility, for it is either supplied by a rapid waste of the tissues or by the histogenetic material of the blood, which is equally impoverishing. We have an example of this in the night-sweats of phthisis.

332. *Defect* of this excretion becomes an important element of disease, by the retention of the effete material which should be thus removed. Many febrile diseases have their origin in this defect, and many chronic diseases are continued by it.

333. *Perversion* of the excretion is not very common, and is difficult of detection. Normally, then, it is acid, and this acidity is sometimes so remarkably increased as to become a cause of

irritation and disease of the structure of the skin. Occasionally it becomes alkaline, at times contains urea or grape-sugar, but we fail to recognize any of these varieties as influencing general disease, and only as they cause skin diseases.

334. *Treatment.*—Where there is *increased* excretion, and it causes debility, such means should be used as will rectify the lesion. The use of the mineral acids is most commonly advised, but to this may be added the employment of tonic, astringent, and stimulant baths, and occasionally the employment of certain vegetable remedies of the class *diaphoretics*, which give tone and strength to this organ.

335. *Defective* secretion from the skin is treated by a class of remedies termed diaphoretics. Some of these greatly stimulate the organ, and produce a profuse discharge of water (sweat), but when continued for a length of time, they are always exhaustive. The most important part of the secretion is elaborated by vital activity of cells, and this is the function to which we are to give most attention. If we desire to remove effete material from the blood, we will accomplish it best by those remedies that cause gentle perspiration (insensible perspiration). This action may be continued for a length of time, and does not exhaust the vitality of the organ. When the skin is debilitated it is important to use friction, stimulants, tonics, and astringents, employing such remedies as we would use for the same conditions in other structures. Fatty inunction sometimes proves serviceable in those cases in which the skin is dry and harsh.

336. It will be recollected that increased temperature, frequency of pulse, and wrongs of innervation, are so frequently associated with deficient secretion of the skin, that we almost look upon these as cause and effect. With frequency of pulse secretion from the skin is proportionately arrested; with increased temperature secretion from the skin is proportionately arrested; with many wrongs of excitation of the nerve centers secretion from the skin is proportionately arrested. Thus with these wrongs we always think of remedies that influence the pulse, the temper-

ature and innervation, as prominent means to establish secretion. There is no better diaphoretic than veratrum when the pulse is frequent and full; than aconite when it is frequent and small; than salicylic acid, quinine in malarial diseases, and baths that control the temperature; than gelseminum, rhus, belladonna, bryonia, macrotys, and other remedies that rectify wrongs of innervation. Not only so, but we may say that any remedy specially indicated by symptoms will increase secretion. Thus baptisia, sulphurous acid, sulphite of soda, muriatic acid, nux, apocynum, and a series of others, though not recommended to excite secretion, are among our best remedies for this purpose when specially indicated. So true is this, that when we select the *right* remedy according to the indications, we are pretty sure that it will right all the wrongs of the disease.

337. Occasionally, when secretion of the skin is defective, we find it prudent to stimulate an increased secretion from the kidneys and bowels, as the function of these organs is to some extent vicarious. In this way we free the blood from the effete material, and give the skin time to regain its tone under the use of proper medication.

338. *Excretion by the Kidneys.*—The kidneys may be regarded as next in importance to the function of the lungs as a depurant of the blood, the urine containing the largest portion of nitrogenized material from the waste of tissue, the mean amount being in the gross about two ounces daily of solid residue. This, according to Lehman, consists of—

Urea	49.68
Uric Acid	1,61
Extractive matter, Ammonia, Salts, and Chloride of Sodium	28.95
Alkaline Sulphates	11.08
Alkaline Phosphates	5.96
Phosphates of Lime and Magnesia	1.97

We thus see that the nitrogenized material forms more than one-half of the whole, and pretty accurately represents the waste of the protein tissues of the body.

339. From a series of experiments Professor Lehman drew the following conclusions, as regards the character of the secretion and the circumstances influencing its formation, which we will find important in the further consideration of the subject: "1. Animal articles of diet augment the *solid matters* of the urine; vegetable substances, and still more such as are deprived of azote, on the contrary, diminish it. 2. Although *urea* is a product of decomposition of the organism, yet its proportions in the urine depend also on the food, for we find that a richly azotized diet considerably augments its quantity. 3. The quantity of *uric acid* depends less on the nature of the diet than on other circumstances, the differences observed in it being too slight to warrant us in ascribing them to the former cause. 4. The protein compounds, and subsequently the azote of the food are absorbed in the intestinal canal; and what is not employed in the formation of the tissues is thrown off by the kidneys in the form of *urea* or *uric acid*, these organs being the chief, if not the sole channel through which the system frees itself of its excess of azote. 5. The urine contains quantities of *sulphates* and *phosphates* proportional to the azotized matters which have been absorbed; and the proportion of the salts is sensibly increased under the use of a larger amount of these substances. 6. In the same circumstances the *extractive matters* diminish, while their quantity is increased by the use of vegetable diet; a fact which proves the influence of vegetable aliment over the production of these matters in the urine. 7. The urine, after the use of animal food, has a strong acid reaction, but contains little or no lactic acid, and no hippuric acid. Under a vegetable diet there is more lactic acid, but it is united to bases. 8. The kidneys not only separate certain constituent parts of the organs which have become inadequate for the maintenance of life, but they also expel the superfluous nutritive matters that may have been absorbed."

340. The urine possesses a well-marked acid re-action, and its average specific gravity is 1020, being greater in summer, when the quantity of urine is least, and less in winter, when the quantity of urine is greatest. By taking the total of urine secreted in

twenty-four hours, and determining its specific gravity, we arrive approximately at the amount of its solid constituents. And if there are no extraneous matters present (the methods of determining which we will hereafter examine) we may reasonably conclude that such solids are in the proportions named in the table given.

341. The nitrogenized solids of the urine are eminently poisonous, and when wholly retained occasion death in a short time. If urea is retained in the blood in small proportion, it causes excitation of the nervous system; in larger quantity it produces a peculiar coma (uræmia), and this increasing causes death. But it is not the action of urea upon the system that we are wholly concerned with. It is formed by the breaking down of tissue, and there are many steps in this retrograde metamorphosis, and through all of this the material is disease-producing when retained, and at some of them more so than when it has reached its ultimate form—urea. We may speak of these as, first, a death of the part which subjects it to the action of chemical laws; second, a decomposition such as we observe in the same material without the body, but effected with greater rapidity; third, a combustion, in which the larger portion of carbon is removed, and giving us a residue of lactic acid and certain obscure ammonia compounds; and, finally, a transformation of these into urea.

342. These processes are accomplished with great rapidity, and with but small portions of material at any one time—the blood being kept constantly freed from it as it assumes the form of urea. But we can understand such conditions as that the material undergoing such change shall be largely increased at any one time, and that the process of metamorphosis may be greatly retarded or even arrested at any one of its stages. And if we take into consideration the character of the material at any one of these stages, we will see that in this we have prominent causes of disease—febrile, inflammatory, or the dyscrasiæ.

343. *Increased* secretion of urine is evidence of rapid tissue-change, and if continued must cause debility. In *diabetes insipidus* the large flow of water washes away an increased amount of

solid matter, and we find it debilitating to this extent. While in *diabetes mellitus* the urine is not only large in quantity, but of high specific gravity, and though the material is grape-sugar, the tissues and the histogenetic food are robbed for its supply.

344. *Defect* in the secretion of urine gives rise to the results above-named (341). In one case we have simply the irritation of small portions of urea, in others the uræmic coma from the retention of larger portions. Again, we will have febrile disease from a retarded and vicious decomposition in the first stage of breaking down, and rheumatism from the increased formation of lactic acid, and other inflammatory diseases from the ammonia compounds. Taking a complete view of the subject in this way, we can estimate the importance of this urinary function in health, and its re-establishment in disease.

345. *Perversion* of the urinary secretion is quite frequently met with, and is, in some instances, a serious cause of disease. I have already referred to the presence of sugar in diabetes, and may instance the presence of albumen in the urine in albuminuria, as expenditures of histogenetic food and tissue, which cause great debility, and, if continued, will ultimately result in death. Again, we have the excretion of the phosphates in increased quantity, thus removing a very important constituent of the body, besides proving a source of local disease. There is a class of compounds formed from the metamorphosis of tissue, but stopping short of the complete form—urea. These are uric acid and the urates (lithates), and the oxalates; and finally, a series of organic products—blood, pus, mucus, organic globules, epithelium, spermatozoa, confervoid bodies, and vibriones.

346. It will be sufficient if I give one method for determining each of these morbid cônstituents, if that method is reliable. For sugar I prefer Barns' test: "Place in a test-tube about two drachms of the suspected urine, and add nearly half its bulk of liquor potassæ; heat the whole over a spirit-lamp, and allow ebullition to continue for a minute or two; the previous pale urine will become of an orange-brown, or even bistre-tint, according to the proportion of sugar present. If now to the colored

fluid a few drops of nitric acid be added, the brown coloration disappears, and the odor of burnt molasses is developed, and in this we have Heller's modification of this test." To determine the presence of albumen, put a portion of urine in a test tube and heat over a spirit-lamp to boiling, when coagulation of the albumen will occur. Take a second portion of urine, and add to it a few drops of nitric acid; if there is coagulation in both cases, the presence of albumen is ascertained. The phosphates are principally determined by the use of the microscope, which detects their characteristic crystals. In cases where they are excreted in large quantity, they often settle toward the bottom of the vessel like a dense cloud of mucus; but if to the urine hydrochloric acid is now added, the sediment at once disappears, which it would not do if it was mucus. Uric acid and the urates are determined by the microscope, having a characteristic crystalline form. The oxalates are determined in the same way, the crystals being thrown down by heating the urine. Blood and pus are also determined by the microscope, as are the entire series named as their associates. There are other tests for them, but for these the reader is referred to special works on the urine.

347. *Treatment.*—When the urine is in *excess*, we would naturally resort to those remedies which would lessen its quantity, among which are the tonic and astringent diuretics, which give strength and tone to the organ. Occasionally we find it of advantage to provide for a removal of effete material by the skin and bowels for a time, that by rest the kidneys may regain their strength.

348. When the secretion is *deficient*, it is common to resort to that large class of remedies called diuretic. If these are used, a judicious selection is of great importance, for they may be classed as sedative, stimulant, exhaustive and tonic; and into those which increase the watery constituent of the urine, *hydragogue*, and those which increase its solids, *renal depurants*. Especial attention is called to the last division, as its neglect is a frequent cause of failure in the employment of remedies. As a general propo-

sition, I may affirm, that if an increase of the watery element is desired, the vegetable diuretics should be employed; but on the contrary, if a removal of the solid constituents, the product of the waste of tissue, be indicated, the saline diuretics should be chosen. The vicarious action of the three emunctories, the skin, kidneys, and bowels, should not be forgotten, for by acting upon the other two, much of the effete material may be removed, and the system for the time relieved, thus giving a longer and better opportunity for a direct action upon the kidneys.

349. We have not only to take into consideration the removal of the waste of tissue, as it is formed ready for the action of the kidneys, but the entire series in the steps of retrograde metamorphosis. There are remedies that influence this process, breaking down feeble forms, and accelerating the transformations necessary until urea is reached. The applicability of such remedies to various cachectic affections, in which the tissues are old and effete, will be readily seen. But I can not pass by this opportunity of calling attention to the fact that, while we thus provide for a more rapid waste, it is indispensable that we also provide for a more rapid nutrition of texture, for these should correspond as nearly as may be with one another.

350. In rectifying the wrongs of the urinary secretion, we do not forget that the general circulation, temperature, and innervation, are to be looked after. Here, as with the skin, in acute diseases, the arrest of secretion is in proportion to the increase of temperature, frequency of pulse, and wrong of innervation. Not unfrequently the right sedative is our best diuretic; as the pulse and temperature come down, secretion is established. When there is a wrong of innervation, corrected by gelseminum, rhus, macrotys, bryonia, nux, quinine, or other remedies acting in this way, secretion is established.

351. It is very important to note the condition of the kidneys, whether it is one of irritation or of atony, for the selection of the remedy will depend upon this. The pain or sharp unpleasantness in the region of the kidneys, down the ureters, in bladder and urethra, is the evidence of irritation; whilst the sense of

fullness, weight, and dragging, is the evidence of an enfeebled circulation and atony. The first requires sedative diuretics, and the second stimulant diuretics. It may also be stated that a remedy specifically indicated by any symptom or expression of disease will favorably increase secretion of urine. Thus the deep-red tongue, calling for muriatic acid or hard cider, then becomes the best diuretic. With the violet-colored tongue, calling for nitric acid, this will act favorably upon the kidneys. It is the same with a solution of soda when the tongue is broad and pallid, or with sulphurous acid when it is red and covered with a glutinous coat.

352. It will not be profitable to consider the treatment of the *perversions* of this secretion at this time, as some of them form distinct diseases, while others are symptomatic of other lesions. In so far as they are dependent upon lesions of the urinary apparatus, we can bring to bear both general and special remedies to prevent them; and, as they are connected with processes heretofore and hereafter considered, their treatment will be named in its appropriate place.

353. *Excretion by the Bowels.*—The amount of material removed by the bowels each twenty four hours averages from four to six ounces; but of this, seventy-five per cent. is water, leaving a solid residue of from one to one and a half ounces. Of this solid matter, the following is the analysis of Dr. Percy:

Substances soluble in ether (brownish-yellow fat)	11.95
" " alcohol of 830	10.74
" " water (brown resinoid matter)	11.61
Organic matter insoluble in the above menstrua	49.33
Salts soluble in water	4.76
Salts insoluble in water	11.61

This is not to be regarded as wholly an excretion, for it contains the undigested residue of the food, and, as we have seen above, nearly twelve per cent. of fat, and sixteen per cent. of salts. We have no means of determining exactly the amount that represents waste of tissue, but we may approximate to it by saying that, in health, one-fifth of the amount represents this waste.

This corresponds very closely with the amount removed by the skin (one hundred grains), and resembles it very closely in its constitution, and its influence upon the system.

354. In olden times it was supposed that the liver performed the most important excretory function in the body; and hence much attention was given to its condition, and to remedies that exercised an influence on its function. Accurate investigation has shown that it is not to be classed with those organs that remove excrementitious material, as it furnished but the smallest fraction of the fæces.

355. As regards the character of this material, and its influence upon the system when retained, I may safely assert that it is analogous to both the secretions from the skin and kidneys There may be constipation of the bowels and infrequent discharges from them, but this does not necessitate a scanty secretion, for the capacity of the bowels is such that they may contain the secretion for many days. This should never be forgotten, as it will prevent our falling into serious errors in therapeutics. It will thus be seen that it is difficult to determine when the secretion is interfered with. Still, as all the functions of the intestinal canal are associated together, and depend mostly upon the same conditions, we may reasonably conclude that when their peristaltic movement is impaired, and their influence in digestion is affected, there is also scanty secretion. In such cases we find derangement of digestion, associated with headache, and more or less febrile disturbance, and we have reason to believe that when this secretion is wholly retained, it will occasion serous disease.

356. *Increase* of this secretion, in proportion to its extent and duration, entails disability, for histogenetic material, either as food or tissue, is removed. Thus we see that profuse diarrheas produce rapid exhaustion. But in the intestinal canal there are two functions associated, the digestive and excretive, the first being of most importance. But when we have derangement of the excretive, especially as an excess, the other must be greatly interfered with.

357. *Defect* of this secretion produces the ordinary effect of

retained excretion. Simple constipation gives rise to derangement of digestion, and the simple retention of effete material in the bowels occasions a feeling af *malaise* and dullness, with headache and fever, in so far as it is retained in the blood or re-absorbed. Cathartics that will remove these accumulations will, for the time being, remove these unpleasant feelings, and for this reason they are so frequently resorted to. Still, we must not forget that this class of medicines tend to exhaust the irritability of the intestinal canal, and in the end really increase its torpor. The habitual taker of cathartics, therefore, finds it more and more difficult to get this action as time passes.

358. *Perversion* of this secretion is met with quite frequently, but is not important as an element of disease. In diarrhea there is almost always some derangement in addition to the excess of water; and frequently, by determining what it is, we are able to check the exhaustive discharge.

359. *Treatment*—In this case I will have to refer the reader to those works which take up the special affections of the intestinal canal for a full description, and only give those general rules that are applicable to all cases. An increased secretion, if not demanded for the removal of excessive waste, should always be arrested. In some cases this is accomplished by the use of those remedies that relieve *irritation*, as aconite, ipecac, bismuth; in other cases, by remedies that free the intestinal canal from a cause of irritation, as a cathartic; in still others, by the use of those which will stimulate and give tone to the intestinal canal, when the diarrhea is the result of local debility, as the essential oils, nux vomica, and certain local and general stimulants; and lastly, by those remedies which constringe and prevent exudation, the astringents.

360. Where there is *defective* secretion from the bowels, it is useful to resort to that class of remedies called cathartics, and with many the more active remedies are employed. It has been noticed by almost every one that an inaction always follows, and is usually in proportion to the increased activity produced by the cathartics, so that it is said by some that the most pressing want

in therapeutics is a remedy which will act thoroughly on the bowels, and yet leave them in a *soluble* (active) condition. To overcome habitual constipation there are no remedies of this class that can be employed with any certainty, and I depend principally upon hygienic measures, which are really the most natural as well as the best. I direct such a person to drink a glass of water on rising in the morning, rub the bowels thoroughly with the hand, and after breakfast solicit a stool. If this is persevered in, a habit will be established which will give a healthy activity of this function, and remove all the derangements that have been produced by the constipation. If necessary, a drop of nux in the morning, or phosphate of soda three times a day, may be used in addition.

DEATH AND LIFE.

361. In the preceding parts of this work I have endeavored to analyze those ultimate processes by which a man has form and activity. We have found a typical structure, the *cell*, simple in its form and arrangements, by its aggregation giving size, shape, and consistency to tissues, organs and parts, and binding them together into a complete body. We found these minute cells possessing an individual life; and, though formed of material that necessarily rendered this life brief, that they possessed a power of development that would continue the same life in new cells having the same place and properties.

362. We observed that life and death were intimately associated together throughout the entire growth, development, and functional activity of organs and parts; that the living body had but a duration of a few months; that it must then die and be removed, that in its place might be developed a new and active body of similar kind; that this death of cells and new development and life of cells gave what, when aggregated, we term life, and that the aggregate life was in proportion to the activity of both these processes.

363. We found that in this constant death of structure and its removal we had the manifestation of life, nervous and muscular, and which gave us a conscious and active relation to the universe; that this consciousness and this activity were in exact proportion to the rapidity of *cell-growth*—nutrition—and this in exact relation to cell-death and excretion; and in addition to all of this, we found that disease was dependent upon a derangement of these processes, as its cure was dependent upon a correction of them.

364. These facts require careful study, and they can not be presented too often, or in too many different ways. And as I have taken them up in detail, I propose now to present their generalization. This I would do myself, did I not find it better done in almost the exact form that I would have to employ. I therefore give the lecture of Dr. Chambers, delivered in St. Mary's Hospital, October, 1861.

"It is true that there are, and always have been, practitioners who declaim against theories altogether, who even boast that they can do without them, and think them useless, not considering that to express such scorn is as if we should be proud of not knowing what we do when we act, or what we say when we talk. To reason at all is to theorize; no one without theorizing can direct a method of cure to a sick person except at hap-hazard. As a matter of fact, none of these objectors ever do prescribe without theorizing about either the individual sufferer or the class to which they refer his sickness, though not always able to put their theory into words. In short, the want of a guiding principle to connect the loose facts of daily experience has at all times been felt.

"From this practical need have been bred the many systems of therapeutics stamping their mark from time to time on the history of our art. They have sprung from the brains of workingmen at the bedside, not from philosophers in their closets. Their adopters have not necessarily any strong faith in their truth or universal applicability; but the heart wearies for a chain to link together the scattered fragments of knowledge—a string

for its pearls; it must have an idea on which to codify the laws of action.

"It would be a long task to quote the curious systems founded on important data, but numbering their hosts of followers in former ages, which have been given up as false and dangerous; I do not wish twice to slay the slain. I shall content myself with putting before you that which influences me in my practice, to which I now proceed.

"Man's body may be likened to a stately mansion, made of beauteous but very perishable materials, all of which are always needing repairs to keep up the shapeliness and usefulness of the building. But not all in equal degrees; some of the walls may stand unaided for years, while other parts may want almost hourly looking after. When the owner leaves the dwelling the repairs cease, and then we see, not all at once, but one after another, the materials falling into ruin. It will serve a purpose in my argument to think over the several steps of this ruin for a few minutes.

"Already while the soul is withdrawing we know that changes begin, very obvious to even the most superficial observer. These changes are mostly due to the loss of water by evaporation. The eyeball loses its brilliancy and gets dry and flat, the features shrink, the gloss leaves the hair and skin. All this goes on all the more rapidly after decease, and then we hide our dead out of our sight, and the future fate of the body is less familiar to us; we must search for exceptional cases or special observations, if we want to know what happens. These we may cull from sundry independent sources. Here is one which old barbarous manners afford us. 'Rizpah, the daughter of Aiah, the concubine of Saul,' watched for the six summer months, from 'the beginning of barley harvest' in April, to the rainy season in October, 'till water dropped upon them out of heaven,' to guard the corpses of her murdered kinsmen from the beasts of prey. So long under the sky of Palestine did they hold out a quarry for the wild dogs and vultures.

"In a moister air decay is quicker, but still not so quick as is often supposed. Here is another observation redolent of the refinements of modern science. The notes made by M. Devergie on the bodies at the Morgue at Paris, show that for two months and a half after decease the muscular structures still keep their natural forms and hues. Up to three months and a half, the scalp, eyelids, and nose, so far retain their ordinary feature that the age of the person may be told. It is four months and a half before complete destruction of the face occurs, or the bones become brittle, and the bulky muscles of the neck and thighs are converted into adipocere. So that we may call three months and a half a short time to be occupied by the decomposition of a human body. So long does flesh last as flesh, and tissue tissue, and is not melted into its mother earth.

"Let us come forth quickly from these ghastly scenes of the charnel-house to the joyous bustle of brimming life, and ask how long it takes not a dead but a living body to decay? 'A *living* body decay?' Yes, in truth; but whereas, in the former case it was a thing to make men shudder, the fading of a long-loved image, the tearing up of a fair garment, the fall of a darling home, the violation of a worshiped shrine, the forcible divorce from our nearest and dearest—it is all this and more—in the latter it is associated with the fullest fruition of all that is joyous in existence, the bounding pulse, the free-drawn breath, the swelling chest, the thrilling feel of health, the highest uses of mind and body. Decay is more truly a part of life than it is of death; for it goes on unstayed through the whole of corporeal being; whereas, after dissolution, it gradually ceases, and ends its work with the reconversion of the organic particles into eternally changeless elements. The most living body is the most active in decay; the more bodily and mental vigor are displayed, the more quickly do the various tissues melt down into substances which are without delay removed by the excreting organs. The more the blacksmith toils with his arms, and the more the statesman with his brain, the heavier bulk of carbon, nitrogen, oxygen and hydrogen is thrown out by lungs, liver, skin, and kidneys.

Do they then wear out by this constant use, friction, and drain? No, no—the more bricks are removed from the old wall, the more new bricks will a good builder put in; and so, provided that the supply is sufficient, and that the builder is a good one, the more rapid the drain the newer and stronger and fitter for its uses will the body become.

"But I will leave generalities, and try to represent in figures how long it takes by living decay for the living body to drain away and to have its substance renewed In the grim details which I recalled to your memory at the beginning of this lecture, the nitrogenous or fleshy parts were most accounted of and especially named as giving shape and the general look of a man to the melting corpse. So of the nitrogenous parts we will now speak. How long are they in being removed by vital decomposition?

"We may reckon with Drs. Bidder and Schmidt that the body of a mammal contains 35.45 grammes of nitrogen per kilogramme, and, therefore, that an animul of 130 lbs. (which is the mean weight of a man) contains upward of 4.6 lbs. of nitrogen.

"Then again, take our numbers from an equally sound and independent source, we may reckon with Baron Liebig that the liquid and solid excreta of a man by kidneys and bowels for a year contain 16.41 lbs. of nitrogen, or for three months and a half 4.7 lbs. of nitrogen.

"That is to say, in three months and a half a quantity of nitrogen is removed by excretion, or vital decay, equal to the quantity of nitrogen in the whole mass of the chief nitrogenous tissue.

"What attractions has this term of three months and a half for us? what memories does it rouse? Why, this was the very time we fixed upon for the fleshy frame-work of the corpse to melt away in. Here is a pregnant fact, a light thrown on the mysteries of nature from a most unpromising source! Dead flesh and living flesh last as nearly as possible the same time—the former, if anything, rather the longer. As far as we can judge, the albumen, fibrin, gelatine, etc., which make up the live body, differ in no wise from the same matters dead; they are liable to the same changes, affected by the same reagents, and naturally

are resolved into their elements in the same time; just as the marble in the Appollo Belvidere is to a mineralogist the same stone as it was in the quarry, liable to the same accidents, and possessed of the same properties, though temporarily endowed with a different value, and made god-like by its adventitious form.

"What, then, raises to the rank of living creatures, and clothes with loveliness, the masses of organic matter which are growing, moving, breathing, thinking, all around us? It is the power of the individual life to create its own individual form. A man has no right of property over the particles of his body, except so long as they remain particles of his body and retain his shape. He hardly calls *his* the snippings of his hair or the parings of his nails, much less the carbonic acid he exhales from his lungs or skin; all that he throws off is by common consent claimed as a perquisite by the public; and the battle-fields which he has fertilized with his blood enrich, not him, but the peaceful farmer. Yet as long as these organic constituents retain the form impressed upon them by the individual life, they are more truly his than any portion of his inheritance.

"A conjectural theory has been hazarded that life mysteriously endows living matter with a defensive virtue which enables it to resist the chemical and other powers acting regularly on inorganic and dead matter. The most notable instance cited is the stomach, which digesting everything else is not itself digested. This consumer of flesh is itself made of flesh, yet is not consumed. An answer seems given to the witty philosopher, who on hearing an alchemist boast his discovery of a universal solvent, inquired, 'In what vessel do you keep it?' The stomach says (it has been in the habit of saying wise things even before the time of Menenius Agrippa), 'In a vessel like me, which is destroyed indeed continuously, but is continuously rebuilt.' Recent researches show that living matter, such as parts of a living animal swallowed for instance, is dissolved by the gastric juice, and moreover that its own epithelial coat is destroyed, but is immediately replaced by a new one. By this activity of growth (the idea of the impudent members calling the belly lazy!), and by a constant flowing

supply of alkaline blood to neutralize any of the acid secretion which might penetrate too deep, it retains the same shape for three-score years and ten. But it has no privileged immunity against the solvent it makes.

"It is then the form which constitutes the self; and it is not the changing, decaying matter which 'was mine, is his, and may be slave to thousands.' The organic materials are the property of the form only so long as it retains them, and no longer—they are a floating capital. Over the innate essential nature of the material it has no control. Life can not make brute materials which it uses live longer than that which it leaves unused, but it has the power of making them anew, and building them up into a certain shape for the time they are made to last. In short, life rests on the metamorphosis or renewal of the body; as this renewal is more thorough, the individual is more perfect, and fulfills better and more completely the duties of its position. If it stops altogether the body is no longer living. If it partially stops the order of normal phenomena is disarranged and ease is expelled —there is a state which we call '*dis*-order' or '*dis*-ease.'

"To speak, therefore, of a 'superabundance of life,' or of an 'excess of vital action,' is a contradiction in terms. There can not be too active a metamorphosis of the tissues into their complete form, for the fresher their organic constituents, the more serviceable they are, and the longer duration they have before them. There can not be too close an adherence to that typical form which it is the business of metamorphosis to keep up, any more than there can be too exact an obedience to law and order.

"The most active metamorphosis of the body possible, the highest possible development of life in every part, is HEALTH.

"The complete cessation of metamorphosis is DEATH.

"The partial cessation, or the exhibition of materials in an incomplete form, however copious they may be, is DISEASE.

"In death the flesh goes on being decomposed as during life; but not being renewed the form is lost entirely. In disease, decomposition goes on, but renewal flags, the incomplete tissues are retained as part of the imperfect body—a sort of 'death in life'—

and are rightly termed by the pathologist 'degenerate.' They are generated, but not *re*-generated; they are generated in an inferior mold of form.

"Take as an example what happens sometimes to voluntary contractile fiber. We all know that if an animal's limbs are duly employed, the muscles keep up their shape and their vigorous power of contraction; their flesh is of a rich, bright red color when the animal is fully grown, and is firm and elastic. Examine it under a microscope, and you find it made up of even parallel fibers, each fiber seeming to be engraved over with delicate, equidistant cross-markings, like a measuring-tape very minutely divided. The more the muscle has been used in a well-nourished frame, the more closely it conforms to the typical specimen of the physiologist:

> 'Use, use is life; and he most truly lives
> Who uses best.'

"But suppose this muscular fiber has been unworked—suppose it is in the biceps of an Indian fakir, who has fastened his arm upright till it has become motionless, or in the gluteus of a soldier's amputated leg, or the calf of a Chinese belle, or in a paralyzed limb—then the flesh is quite different in aspect; it is flabby and inelastic, of a pale yellowish hue, and makes greasy streaks on the knife that cuts it. Sometimes even all the traces of fibres have disappeared, and it is converted into an unhealthy fat. Sometimes you may trace fibers under the microscope, but their outline is bulging and irregular, the cross-markings are wanted, and you see instead dark, refracting globules of oily matter in them. In short, the muscle is degenerating into fat, retaining in a great measure its shape, but losing its substance. Such is, by God's law, the penalty of not using His gifts for four or five months.

"Now go back to our first sepulchral illustrations. M. Devergie found that, in a period between four and five months, the flesh of a corpse is converted into a substance technically termed 'adipocere:' an oleaginous substance between fat and wax—an artificial fat, the result of chemical decomposition. What is this but precisely that which happens to the disused muscles in the

cases quoted? At the Morgue a continuous stream of water washed away the fetid gases from the subject of M. Devergie's observations, and in the living body destructive metamorphosis and excretion remove the more directly noxious particles; in both there remains the same oleaginous residuum.

"The instance chosen of diseased structure was purposely an extreme one; but even there a very high degree of partial death was seen not to be inconsistent with life. A less degree is not inconsistent even with active usefulness. Look at many a man whom his physician knows to have a weak or slightly dilated heart; he goes on with his profession, mixes in society, enjoys his quiet pleasures, and may even insure his life by paying an extra premium. Yet if an accident at any time should cut him off suddenly, the muscular tissue of the heart will be found pale and soft, while under the microscope the fibers are seen deficient in clear outline and in cross-markings, and exhibit here and there minute specks of that fatty degeneration which was so conspicuous to the naked eye in M. Devergie's subjects and in the completely palsied limb. The more dilated and the more weak the heart, the more wide-spread is this degeneration. Yet enough of active structure is left to carry on the work of the heart, and perhaps to prolong life to its allotted three-score years and ten.

"A close copy of the pathological process may be made by soaking a piece of muscle, say from a healthy sheep's heart, in a running stream, in weak spirits and water, or in nitric acid and water, for a few weeks, when sections made from time to time will exhibit the several stages of fatty degeneration, from the minute specks in the scarcely-altered muscle up to complete conversion into adipocere.

"Remark in these cases of fatty degeneration or decay, that the substance which replaces the highly organized animal matter is not utterly inorganic. It is less organized and less organizable, but still capable of being called alive. Of our living bodies fat is a part, and a necessary part; but still it is not capable of performing the highly vital duties of muscle, of being as thoroughly alive. Degenerated products, therefore, so long as they form part

of the body, may still be said to be alive, but *less* alive than the normal tissues they replace; and degenerate growth may be justly described as 'diminished life,' or, in the words I lately used, 'partial death.' Degeneration, in short, is a more or less relapse into a lower and lower form of organic life, and exhibits itself, therefore, in a variety of grades and amounts. Occurring in various parts, it occasions three-quarters of the chronic illnesses which give work to the physician.

"Let it be well understood that these half-living tissues are by no means necessarily lessened in size. A battered and renovated vessel is often much bulkier than a strong new one; and in the same way these under-nourished parts are often enlarged, and so have been wrongly supposed to be over-nourished. They often attain a most cumbersome weight and bigness, without really containing tissue enough to do their work. They become in truth a foreign substance. Sometimes they acquire what seems like a parasitic life, and grow as if independent of the body which they inhabit. Then you justly look upon them with a peculiarly unfavorable eye, and call them by the epithet 'malignant.'

Cancer is the best known example to quote; and you who have watched its deadly quickness of growth are, perhaps, wondering that it should be put forth as an instance of lessened vitality. But watch further with the mind, and not with the eye only; you will see that the abnormal tissue never gains the higher characteristics of life, never puts on the *form* of the part invaded, nor performs its duties. Moreover, that half-life, so easily acquired and so easily multiplied, is also easily lost. The very tendency to die and to ulcerate is one of the chief dangers in which cancer puts your patient.

"But we are now driven to seek our illustrations among these dreadful sorrows of our kind, when we can find them in less painful scenes. Every one connects cancer and degeneration with death; but perhaps it is not quite such a familiar idea to see partial death in a cold in the head or relaxed throat. However much you may smile at the notion, it is a true one, and I should advise your taking the next chance which a catarrh gives you of

seeing the truth in all its bearings. It is almost worth while to catch one on purpose, so valuable is the lesson. And perchance your smile may become a grave and thoughtful one, when you reflect on the miseries of life; when you think that the slight inconvenience you are bearing is of the same nature as that which divorces soul and body, a distant and indistinct foretaste of that dread cup which we must all one day drain.

"Look at our catarrhal throat in a mirror—what do you see? The surface red, puffy, and with the component parts, such as the uvula, enlarged. There is also poured out a quantity of slimy material, which you will know by the name of mucus. At first you may be disposed to cry, 'Surely here is an active business going on; every thing seems much more lively than usual; life is increased, not diminished.' Not so fast—examine in a microscope a little of this mucus, and you will find it made up of minute balls of transparent jelly, with a granular aspect, technically called 'exudation globules,' 'mucous globules,' and 'pus globules,' floating quite free, and rolling over and over, without any tendency to adhere together. Are these bodies a new creation, something which an inflamed membrane can produce, while a healthy one lacks the power? Are they evidences of an additional life-force? By no means, for they have been identified with those elementary forms of nascent life by which all organic matters grow; they are young cells, or rather nuclei. They are the form assumed by all liquid living material, which, under the influence of life, is being transformed into a solid; they are an infant tissue strangled in its birth. Instead of uniting into a continuous web to clothe with epithelium the surface of the membrane, they float off, helpless from deficient vitality. The business of mucous membranes is to be covered with epithelium, not to throw off mucus; and when they are doing the latter, they are so far forth in a state of diminished life.

"But you may ask, what is that redness and that throbbing of the inflamed part? Do they not show an increased circulation of the vital fluid, and therefore increased life? Quite the contrary, for the membrane is red because its blood-vessels are re-

laxed and dilated from loss of vital elasticity; the blood sticks in them as water in a bulged pipe; and the arteries, pressed upon from behind by the heart, throb because the obstruction impedes their actiou.

" 'But the pain—does not that show that the vital power of sensibility is increased? I can not, in general, feel that I have got a throat, and now I am reminded most disagreeably of the fact.' No; pain does not indicate an increase of proper sensibility; in this case it is associated with a very marked decrease. During your catarrh the lining membrane of the fauces loses its delicate appreciation of flavors—every thing is equally nasty, unless there is a pungency in it too powerful to be pleasant to the healthy taste. And it is wanting also in common sensibility; for it does not distinguish the shape or size of morsels swallowed, all of which feel equally large and awkward.

"Or you may get a whitlow on your finger, or a boil, and study how the nail is stayed in its growth, and the skin is killed, while the materials intended to renew them are checked in their development, and go to be deposited as pus, a concentrated form of half-vitalized fluid, very similar in every respect to mucus. And, like your catarrhal throat, your inflamed finger-tip is wanting in sensibility; try it, and you will find for any delicate work, such as feeling the fine lines of a copper-plate, or the flaws in a polished surface, it fails in its duty. Pain, in short, is the brother of death; a painful part is never performing its whole vital functions—it is partially defunct.

"The same partial death, which has been hitherto described as constituting the various diseased states of the solid structures of the body, may also attack the fluids; and in them, as in the solids, it may show itself either as a destructive relapse into a less organic life, or as an arrest of development. The poison of fever, for example, destroys and renders useless as nutriment some constituents of the blood; the insufficient blood is circulated to all parts of the body, causing, not local pain, but general *malaise* by its deficient vitality. The half-poisoned tissues allow the poisoned material to ooze through them, causing diarrhœas, hemorrhages,

purple blotches on the skin, and a general staining of the whole body of a dusky hue. If the quantity of blood poisoned be moderate, it can be spared; it is carried off gradually by excretions, and its place is filled up by new blood. But if the rare case happens of so much being poisoned at once that too little remains to carry on the business of the body, then death occurs by sudden shock; or if there be an insufficient supply of material to take the place of the blood, the vitality wanes away more slowly. And as its loss occurs more slowly, some one part more than another is usually affected; there is inflammation—that is, local death—of the digestive viscera, or of the lungs, or of the brain, and the patient's disease is allotted by name to that last clause. And thus in fever, the blood relapses into a less organic form through its vitality being destroyed by a morbid poison.

"Let us next look for an instance of imperfect life in the blood occasioned by arrest of development. You are all probably familiar with the common condition we call anæmia. The word literally means 'bloodlessness,' but in reality relates rather to deficient quality than deficient quantity. The circulating fluid can not but fill the closed vessels, but it is wanting in the most highly organized, the most truly living, of its constituents. It is pale from the diminished numbers of those floating red globules which give its florid hue. The capital of red globules is by far the most important portion of the blood; so much so, that it may be taken as a direct measure of corporeal and mental vigor; a man has a larger proportion than a woman, a strong man than a weak man, an adult more than a youth or an elder, a patient after recovery more than during his sickness of whatever kind, a horse in high condition more than when brought from grass. Spite of its importance, we find to our surprise that this floating capital may be largely encroached upon without bankruptcy. For example, Dr. Andral has analyzed the blood of a patient with anæmia, where the blood-globules amounted to less than 39 parts in 1,000, whereas their natural proportion should be at least 120 parts in 1,000. More than two-thirds of this constituent were missing! Yet the patient was living, and very likely quite re-

covered in the end if rational treatment was adopted. Now, in anæmia there is not found any degenerated devitalized substance; the missing globules have not relapsed into a lower life, so that their ruins should constitute a foreign matter; there is no debris in any quantity at all proportioned to the deficient globules; they have been used up in the regular way, and have supplied materials for the tissues, as they are moulted off from day to day; while at the same time there has been a want of renewal, an arrest of that continuous development of blood, which is necessary to complete life.

"Pure anæmia has been spoken of; but, as might have been expected, this defective supply of the materials of growth much weakens the vitality of many of the manufacturing and excreting viscera; for their machinery needs continual repair, as much as any part of the voluntary apparatus. Hence, in cases of anæmia we often find that the liver is not so lively as it should be, and some of the color it ought to get rid of stays in the circulation, or exudes and chronically stains the skin of a bilious hue. Or perhaps the kidneys do only half work, and the urea which they ought to drain off is retained, causing very serious derangement of health. Thus there is a mixed pathology in these cases, a combination of arrested life with a relapse into a lower life; the life of the specially-affected organ is diminished, and it leaves behind in the system substances of inferior vitality which its proper business is to excrete or separate.

"Or again, anæmia may so lower the creative power of the blood, that instead of the body being built of elastic and highly vitalized fibrin, it has to put up with a cheesy, brittle substance called tubercle. This is just the sort of fraud a rascally contractor commits when he lays your floors on half seasoned timbers. Your house is destroyed by dry-rot; and the lungs in which tubercle has been substituted for healthy connective tissue gradually soften and break up. The most effectual remedy in both instances is to look after the builders, to secure the honesty of the one and the vitality of the other as far as possible.

"When the various accidental circumstances of our daily habits dispose various parts of the body to even the few elementary forms of disease which I have mentioned here, a great variety of abnormal phenomena may be produced. Our body is a harp of so many strings, that all sorts of discords may rise out of its combinations. These discords have received much attention from minds with a taste for order; they have been classified into groups; and if, unfortunately, the orderly mind was afflicted with a theory, sadly have facts sometimes suffered by the Procrustean bed of a nosology, into which they have been forced. On the whole the nosologists (*Νοσολογοι*—people who talk about diseases) have been convenient, for their nomenclature often helps us to describe in one word what otherwise would want a parenthesis. But they have been a convenient evil, and their labors have had this bad result: they have attributed a positive existence to that which in reality is a negation. '*A disease*' under this manipulation, instead of being a mode in which life is deficient, becomes an actual motive power; the giving it a generic and specific name links it in our minds with the subjects of a naturalist's studies, and we get to clothe it in individual characteristics, and to assign to it individual actions. The consequences in science have been most fatal to true progress. It has had upon the art of medicine just the effect that would be wrought upon optics by regarding a shadow as a material object instead of an absence of light, upon physics in general by accounting cold instead of heat as the active agent.

"I am glad to say less practical harm than might have been feared has been done by these false notions. In the first place man's body is tougher than usually thought, and will stand a great deal of wrong treatment; and, secondly, experience has somewhat checked the bold hand of a relentless adhesion to theory. Still, it can hardly be doubted that the increased chance of cure under professional treatment has not been so much as might have been expected from the advance of general knowledge.

"Of late medical art, as far as practice is concerned, has been turning over a new leaf; nosologists are of less repute, and at last, under the influence of common sense, attention seems di-

rected to the maintenance of life *in* the body more than to the expulsion of death *out* of it. Such is the true preaching to the sober mind of the new modes of treatment which, without falling in with the dogmas of any particuliar '*pathy*,' have yet been silently adopted by the rational adherents of each within the last few years. I may instance the care bestowed upon the selection of alimentary substances; the use of water, of oxygen, of iron, of animal oils, of chlorine, of soda in doses more like food than a drug, of lactic and other organic acids, of salts of phosphorus and lime, of sulphur, ammonia, bile, pepsin, and several other agents established by common consent without being suggested by any previous theory of therapeutics, or traditional rules of the medical art. These are constituents of the animal frame, and are administered and trusted as to filling up an obvious void.

"If experience has taught us to reform our practice, should it not teach us to reform our theory too? that so the partial advantages which have been gained might become universal, and our words and acts might cease to be inharmonious.

"I began this lecture by likening the animal body to a building constructed of perishable materials, which need continuous renewal to maintain the usefulness of the structure. To keep up the simile, the permanent architect is the indwelling life, and he best performs his duty, not by fits and starts of work, but by ever-watchful industry. He should be every moment removing decaying materials from the walls and working machinery, to be carted away at convenient periods, and he should be every moment supplying their place by fresh. Thus there are two departments carried on simultaneously—the 'destructive' and the 'constructive;' and upon their harmony and completeness depend the perfection of life which we call health. Both are necessary; and the deficiency of either or both, or the preponderance of one over the other in various parts, or their deficiency in one part while the other parts remain active, constitutes a deficiency of life—a disease.

"This deficiency the physician is called upon to remedy; and it is of the utmost importance to his usefulness that he should re-

cognize that it is a deficiency, and act upon the recognition. He must look at his pharmacopœia with this thought constantly present before him, with an eye to the ultimate benefit of the patient, to a goal beyond that of the immediate effects. He should make his chief thought how each of the re-agents employed will finally touch life; whether they are calculated to add to or diminish the vital functions, to add to or diminish the vitalized substance of which his patient is made—whether by temporarily diminishing the function or substance he may not remove an impediment to their balanced actions, so as to lead to a final increase—or whether this artificial diminution of functions or substance may not become permanent, and inflict permanent injury on his patient. This final goal of life renewal must be consciously or unconsciously in the heart of the physician, or in the heart of his guides; otherwise I am sure he contributes more to the ill health than to the good health of mankind."

365. This subject of the "renewal of life" is, as Dr. Chambers states, one of the most important studies of the physician. In the continued renewal of tissue we have renewal of life; if this is active we have active life; if it is slow we have a sluggish life; and if it ceases we have death. This has been discussed to some extent under the head of degeneration, but we will lose nothing by thinking of it again. In many cases of disease we find the person with an *old* and feeble body, which, in consequence of slow and imperfect renewal, is not able to perform the functions of a body. We recognize it by the sluggish movement, want of functional activity, and the ill-fitting tissues which seem to hang upon the skeleton. What is to be done in such a case, to establish normal life? Certainly there is no other way than to grow a new and better body.

366. In some diseases, of which syphilis might be named as an example, we find this slow and poor renewal of life, the tissues being syphilized, and to this extent impaired. How is this syphilized body to be made healthy? Certainly by washing it away

through the excretions, and building a new and better body in its place.

367. Here is a feeble organ which will not do its work, no matter how much we stimulate and urge it by drugs, and when we come to think of it, we realize that here also is an old and feeble tissue that can not do good work. It may be a brain, a stomach, a liver, a heart, lungs, or an intestinal canal; the principle is the same—old tissue can not do good work, and therefore if good work is to be done, a new organ must be made under better conditions, and re-made from four months to four months, until we have one that has full capacity for the work.

368. Let us start at the commencement and think it over. What are the conditions necessary for the renewal of life? Good light, good air, right exercise, good food, good digestion, good blood-making, a good circulation, good cell-making. These are the factors of the new body or organ that is being made, but the ground must be cleared for it, and the old body removed, and this requires a second series of conditions, which are—good breaking down of old tissue, absorption into the current of blood, oxygenation and burning of the carbon, retrograde metamorphosis to fit the nitrogenized material for excretion, and lastly an active condition of the excretory organs to remove the nitrogenized waste.

369. Add to these, that the body must be maintained at a right temperature, and electrical condition, and that we must have all these functions co-ordinated by a normal innervation, and we have the subject pretty clearly before us.

370. If now we think of remedies to facilitate the renewal of life, those will be first suggested that facilitate the removal of the old body. We have a group of remedies like acetate of potash, the iodides, and some vegetable remedies, that break down old tissue, and facilitate retrograde metamorphosis. Then we have others which, with well regulated exercise, facilitate combustion, and the removal of carbonaceous waste. Then comes the first group of conditions, for which we have a series of remedies looking after good digestion, blood-making, etc.

CHAPTER V.

THE BLOOD.

371. THE study of that complex fluid, the blood, is one of the most important in medicine, as it not only supplies the material for the growth and repair of tissue, but is also the channel through which the waste of tissue is removed. Penetrating every part of the body, and coming into contact with the most minute part through capillary distribution, all parts are influenced by its condition.

372. The blood has a distinctive vitality inherent in itself, by which it appropriates the material furnished by digestion, and forms it after its own similitude. We observe, likewise, that it is extremely sensitive to impressions, having a form that is easily influenced, and were it not that it is so thoroughly protected by its enclosure, it would not be possible for it to retain such form as adapts it to the purposes of the body.

373. This susceptibility to change is strongly insisted on by Liebig. He says: "The blood is not an organ which is formed, but an organ in the act of formation; indeed, it is the sum of all the organs which are being formed. The chemical force and vital principle which hold each other in such perfect equilibrium, that every disturbance, however trifling, or from whatever cause it may proceed, effects a change in the blood. This liquid possesses so little permanence that it can not be removed from the body without immediately suffering a change, and can not come in *contact* with any organ in the body without yielding to its attrac-

tion. The slightest action of a chemical agent upon the blood exercises an injurious influence; even the momentary contact with the air in the lungs, although effected through the medium of cells and membranes, alters the color and other qualities of the blood. Every chemical action propagates itself through the mass of the blood; for example, the active chemical condition of the constituents of a body undergoing decomposition, fermentation, putrefaction, or decay, disturbs the equilibrium between the chemical force and vital principle in the circulating fluid. Numerous modifications in the composition and conditions of the compounds produced from the elements of the blood, result from the conflict of the vital force with the chemical affinity, in their incessant endeavors to overcome one another."

374. Studying the blood as a whole, we may consider it in the following relations: 1st, as an organ to adapt the material furnished by digestion to the purposes of nutrition; 2d, as a depot of supply, and a means of conveyance to all portions of the body; 3d, as a vehicle for conveyance of oxygen, and probably as the place where the combustive process principally goes on; 4th, as a vehicle for the removal of the waste of tissue, and in which those changes are effected that fit the material for excretion; 5th, as a vital stimulant of all parts, being the store-house for the excess of vital or formative force (?)

375. *The blood making function* is necessarily one of the most important in the economy, and must be perfectly performed if the body remains healthy. Observers have been at a loss to determine what part of the organism performed the blood-making function, and there has been much discussion in regard to it. I believe it is now admitted that, while aid is rendered by the mesenteric glands, and probably the spleen and liver, the blood is itself the blood-making organ. This would be in proper analogy with other processes—a muscle reproduces itself by power inherent in itself, so does the brain, secreting structure, connective structure, etc., and why should the blood, which possesses a distinct organism, be an exception to this rule? All the facts of observation in the healthy and diseased state go to prove this

view, and until facts are discovered which conflict with it, it will have to be considered correct.

376. The fluid portions of the food absorbed by the veins of the stomach and intestinal canal are passed into the portal circulation, which is again divided into capillaries in the liver, and the new material is thus brought into intimate relations with this large organ. If we examine the liver in its relation to fœtal life, and its proportionate size and work in the mature animal, I think we can not doubt that it is a blood-making organ. So too we find the evidence in its pathological conditions, for structural lesions of the liver always work a wrong of blood-making.

377. The mesenteric glands receive the entire current of chyle absorbed by the lacteals, and here the new material is brought into the closest relation with the circulating blood. On the side next the intestinal canal the lacteal vessels contain chyle, whilst on the side next the heart they contain lymph—the change being from chyle to a finely organized bioplasm, fitted for the uses of the body. If there is disease of the mesenteric lympatics, the blood suffers, and the material is sometimes so imperfect that it cannot be formed into good tissuse. This we also note in all wrongs of the general lymphatic system, which most certainly furnishes the germs of organized blood. If these mesenteric glands are so diseased that the chyle can not be passed through them, the person dies of marasmus.

378. What circumstances favor the blood-making function? The principal conditions are three, all of which are necessary to its proper production; they are these: (*a*) that the blood itself shall have good vitality, formative power; (*b*) that the processes of digestion shall have furnished a material capable of forming blood; (*c*) that the blood shall be free from noxious agents, especially the waste of tissue, or material undergoing decomposition. It will be noticed that these circumstances are to a considerable extent under our control, and while we may correctly estimate the lesions of the blood by understanding the conditions of its production, we may also obtain definite ideas of the means necessary to correct its lesions.

379. The vitality of the blood, or its formative power, is strong just in proportion to its activity, *i. e.*, the rapidity with which the blood is renewed. This we have heretofore seen to be an absolute law in the development of all parts of the body. An active nutrition of texture, and a vigorous circulation, are the elements of rapid and good blood-making. If there is deficiency in the blood-making power, we increase it by the use of bitter tonics, iron, and other restoratives, and a good nutritious diet, with general exercise to create a demand for nutrient material.

380. A normal condition of the digestive organs is essential to the formation of good blood, as derangement of these organs is very frequently the cause of poor blood. It is not only essential that a proper supply of good food be taken, but that this be divested of all previous organic forms, for unless it is in this formless condition (*plasma*) it can not gain entrance into the blood-vessels. And it is also essential that in this process of disruption, no chemical change should be allowed to progress that would lower the character of the material as being suited for organic forms.

381. There is one fact that impresses itself upon the mind here, and that is that the human body is incapable of using any material that has not, by previous vital action, been brought into such state that it can be molded into cell-structures. It must, therefore, have been formed from the inorganic elements by the plants which possess this power, and from which man receives it directly, or by the interposition of other animals. If there is the slightest disruption or breaking down in the constitution of its elements, it can not be used in the human body. This subject received a partial examination when we were considering food with reference to nutrition.

382. The third requirement, "that the blood shall be free from noxious agents, especially the waste of tissue," is fully as important as either of the others. The action of effete matter upon the forming blood is always to lower its vitality, and occasionally its influence is so marked in this direction as almost to arrest the formative *process*. Where such material is present in the blood,

we find that the most certain means of getting good blood is to employ such remedies as will change the effete matter into urea, and promote its elimination by the way of the kidneys.

383. *As a depot of supply and a means of conveyance* to the tissues, it serves a second important purpose. Regarding this, we will be careful that nothing gains entrance into or remains in the blood that will impair the store of nutritious material. We have here a second reason for active excretion. As a means of conveyance, the blood conveys this necessary material for the supply of all, even the most minute parts of the body, and as we have already seen while examining the function of nutrition, it is one of the most important conditions of that function. A regular and equal circulation of blood is not only necessary to bring it within reach of the tissues, but is absolutely indispensable to the life of the blood. *Stasis* of blood always impairs the vitality of this fluid, and we will not be far out of the way, if we say that this impairment will be almost in direct ratio with such impediment to its movement.

384. We have many examples of this, and I do not now recall a single exception. Every one has witnessed the lesions of the blood following the slight congestions of the uterus in amenorrhœa; sometimes they are very marked. A protracted chill with congestion always impairs the blood. While in the severer congestive fevers the vitality of the blood is sometimes wholly destroyed during the stasis of blood in the cold stage. I have examined it twice in such cases, and found that it had lost the property of coagulation, of change of color upon exposure to oxygen, and the microscope showed the globules in process of breaking down.

385. *As a vehicle for the conveyance of oxygen* the blood performs one of the most important functions of the body, one which can not be arrested for a moment without endangering life. Though the entire blood is a carrier, yet the red globules are the principal vehicles, and we will consider this function fully when we examine the history of these. I think it is pretty evident that the combustive process takes place principally in the blood;

that heat is liberated in it, and by it conveyed to all parts of the body. We have here one more reason for an equal circulation of blood to add to many others we have already considered. If vital actions require a certain definite amount of heat, never varying more than a degree or two without their arrest, the importance of an equal distribution of blood (thence heat) can not be overestimated. It is the custom of some to laugh at the direction, to *equalize the circulation*, but where the laugh properly comes in I am unable to see, as an equal circulation is not only important but the means for attaining it are in common use. This point may be rendered more distinct by an illustration. In the latter stage of continued fever, when the vitality is much depressed, there is tendency to coldness of the extremities, necessarily enfeebled circulation in them, and in exact ratio to this a stasis of blood in internal organs. Sometimes the life of the patient will depend upon *equalization* of the circulation; by the use of stimulants, friction, and warmth, we return the circulation to the extremities, and by this means remove the internal congestion. I have seen more than one case in which the difference between life and death was the difference between warm and cold extremities.

386. *As a vehicle for the removal of the waste of tissue* the function of the blood is important, and we are anxious that it perform this function with due celerity, otherwise it would become a depot for such material to the great detriment of the body. The only control we have over this function is, to see that the blood circulates freely, neither too fast or too sluggish, and that it is freely passed through the excreting organs. The failure as a carrier of waste will more frequently follow an imperfection of the circulation in the special excretory organs than in the system at large.

387. The *process by which the waste is fitted for excretion* undoubtedly takes place in the blood, and is of much importance. We can not tell accurately the steps in this retrograde metamorphosis, but we have sufficient examples of its derangement in rheumatism, in phosphuria, oxyluria, etc., and more obscurely in fevers and inflammations. These processes can be accelerated by reme-

dies, and we find their use important in all diseases in which the blood is loaded with waste.

388. There is no doubt that the blood acts *as a vital stimulant to all parts,* but to what it owes this property is not easily decided. It is claimed by some that it is the oxygen it conveys, and this view is strengthened by the fact that this stimulant is in proportion to the red globules, and when these are deficient there is deficient stimulation. Others claim that it is dependent upon the nutritive material it supplies the tissues, as it goes its ceaseless rounds. I think it evident that it possesses the property from both of these, and in addition, from being a store-house of heat, electricity (?), and of formative force. I have supposed a surplus of formative or vital force as a connecting link between all parts of the body. We have seen that the blood employs such force for the common welfare in organizing and fitting the material for the nutritive processes, and any excess there might be in the body would naturally reside in the blood, which is common to all.

THE CONSTITUENTS OF THE BLOOD.

389. The first and most evident division of the blood is into two parts, the one possessing an evident organization, the other being without organization. The first consists of the *red and colorless corpuscles,* which, when moist — *i. e.,* containing their natural amount of water—form five hundred and twelve parts; the second, the *liquor sanguinis,* a compound fluid, being four hundred and eighty-eight parts. Recollect that in this division the corpuscles retain their normal volume of water, and are in the condition in which they circulate in the blood-vessels.

Upon close analysis the blood is found to have the following constitution:—

	Water	784.00
	Albumen	70.00
	Fibrin	2.20
Red corpuscles	Globulin	123.50
	Hæmatin	7.50
Fats	Cholesterine	0.08
	Cerébrine	0.40
	Seroline	0 02
	Oleic and margaric acid, Volatile and odorous fatty acid, Fat containing phosphorus,	0.80
	Chloride of sodium	3.60
	Chloride of potassium	0.36
	Tribasic phosphate of soda	0.20
	Carbonate of soda	0.84
	Sulphate of soda	0.28
	Phosphates of lime and magnesia	0.25
	Oxide and phosphate of iron	0.50
	Extract, salivary matter, urea, biliary coloring matter, accidental substances	5.47
Total		1000.00

[*Draper*.

390. We will consider these elements in the following order, and as normally existing in the proportions named: Red corpuscles, 131 parts; albumen, 70 parts; fibrin, $2\frac{1}{2}$ parts; fats, $1\frac{1}{3}$ parts; salts, 6 parts; excreta, $5\frac{1}{2}$ parts; water, $783\frac{2}{3}$ parts.

RED CORPUSCLES.

391. There is still some doubt regarding the constitution of these bodies, and physiologists are not agreed as regards their structure and relation to other cell formations. In early fœtal life they are spherical, white, and contain a distinct nucleus; after this they are red, disc-shaped, and nucleated; but by the third month they assume the form they are afterwards to maintain—red, disc-shaped, bi-concave, and without a nucleus. If we trace their development in the invertebrated animals, we find, first, coarse granule cells, then fine granule cells; and when they have attained their greatest development, they resemble fœtal blood cells of man—the colorless nucleated cell.

392. This inquiry into the structure of the red corpuscles is important, that we may determine how they are formed, and to some extent their relation to the other parts of the organism. Heretofore we have seen that cells possessing an independent

vitality, and having the power of propagating their kind, are invariably *nucleated*, and that their reproduction is by division, which always commences and proceeds from the nucleus. We have here a class of cells that differ from formative and secreting cells. The following quotation from Virchow will further illustrate this :—

"You will hereafter be made acquainted with a series of facts in the history of pathological and physiological development, which render it in a high degree probable that the nucleus plays an extremely important part within the cell, a part, I will here at once remark, less connected with the function and specific office of the cell than with its maintenance and multiplication as a living part. The specific (in a narrower sense, animal) function is most distinctly manifested in muscles, nerves, and gland-cells, the peculiar actions of which—contraction, sensation, and secretion,—appear to be connected in no direct manner with the nuclei. But that, while fulfilling all its functions, the element remains an element, that it is not annihilated nor destroyed by its continual activity—this seems essentially to depend upon the action of the nucleus. All those cellular formations which lose their nucleus have a transitory existence; they perish, they disappear, they die away or break up. A human blood corpuscle, for example, is a cell without a nucleus; it possesses an external membrane and red contents; but herewith the tale of its constituents, so far as we can make them out, is told; and, whatever has been recounted concerning a nucleus in blood-cells, has had its foundation in delusive appearances, which certainly very easily can be, and frequently are, occasioned by the production of little irregularities upon the surface. We should not be able to say, therefore, that blood-corpuscles were cells if we did not know that there is a certain period during which human blood-corpuscles also have nuclei—the period, namely, embraced by the first months of intra-uterine life. Then circulate also in the body nucleated blood-cells, like those seen in frogs, birds, and fish throughout the whole of their lives. In mammalia, however, this is restricted to a certain period of their development, so that at a

late stage the red blood-cells no longer exhibit all the characteristics of a cell, but have lost an important constituent in their composition. But we are also all agreed upon this point, that the blood is one of those changeable constituents of the body, whose cellular elements possess no durability, and with regard to which everybody assumes that they perish, and are replaced by new ones, which in their turn are doomed to annihilation, and every-where (like the utmost cells in the cuticle, in which we also can discover no nuclei, as soon as they begin to desquamate) have already reached a stage in their development when they no longer require that durability in their more intimate composition for which we must regard the nucleus as the guarantee.

"On the other hand, notwithstanding the manifold investigations to which the tissues are at present subjected, we are acquainted with no part which grows or multiplies, either in a physiological or pathological manner, in which nucleated elements can not invariably be demononstrated as the starting points of the change, and in which the first decisive alterations which display themselves do not involve the nucleus itself, so that we often can determine from its condition what would possibly have become of the elements."—*Virchow*, pp. 36–38.

393. *Development of Blood-Corpuscles.*—As the red corpuscles are not formed by the ordinary cell-process of division; and as they have not the power to propagate their kind, and are not formed within the blood—the three important attributes of cell-life—we will have here an entirely new investigation. We want answers to the questions: Where are these bodies produced? and how are they developed? In regard to this, Virchow remarks:

"The whole history of the red blood-corpuscles is still invested with a mysterious obscurity, inasmuch as no positive information has even at the present time been obtained with regard to the origin of these elements. We only know this much with certainty, that a part of the original corpuscular elements of the blood proceeds just as directly from the embryonic formative cells

of the ovum, as all the other tissues which build themselves up out of them. We know, moreover, that in the first months of the existence even of the human embryo, divisions take place in the cells, whereby an increase in the number of them present, in the blood itself, is produced. But after this time all is obscure, and this obscurity indeed corresponds pretty exactly with the period at which the corpuscles in the blood of man and the mammalia cease to exhibit nuclei. We can only say that we are acquainted with no fact whatever which speaks in favor of a further independent development, or of a cell-division, in the blood, but that everything points to the probability of a supply from without. The only hypothesis which has, in more recent times, been advanced with regard to the independent development of the blood-corpuscles in the blood itself, is that of G. Zimmermann, who assumed that there were little vesicles present in the blood, which gradually grew by intussusception while circulating with it, and ultimately constituted the real blood-corpuscles. Now, little corpuscles certainly do occur in the blood, only when they are more accurately examined, a peculiarity reveals itself which is unknown in young embryonic forms, namely, that they oppose an extraordinary degree of resistance to the most different agencies. In their ordinary state, they are of a beautiful dark red, the color being very intense, and frequently very black; if they are treated with water or acids which dissolve the ordinary red corpuscles with ease, is is observed that the little bodies require a very much longer time before they disappear. Upon adding a large quantity of water to a drop of blood, they will be seen to remain for a considerable time after the other corpuscles have disappeared. This peculiarity accords best with what occurs in the changes which take place in the blood, when it is extravasated, or remains for a long time stagnant within the vessels. Such changes undoubtedly lead to a destruction of the corpuscles, so that in the case of the circulating blood also, the conclusion may, with great probability, be drawn, that the bodies in question are not young forms, engaged in development, but, on the contrary, old ones in the process of decay. I agree, therefore, essen-

tially with Karl Heinrich Schultz's view, who has described these bodies under the name of melanic (melanose) blood-corpuscles, and regards them as the precursors of the *moulting* of the blood (Blutmauserung)—preparing for the really excrementitious transformations."—*Virchow*, pp. 258–260.

394. I think there is no doubt but that the red corpuscles have their origin in the lymphatic glands, as do the colorless corpuscles. For we find in the lymph passing onward to the blood, numerous bodies bearing a close resemblance to the blood-corpuscles. Though they have their birth in the lymphatic glands, and from the lymph, yet they attain a more perfect development when introduced into the blood of which they are to form a part. Virchow seems to arrive at this conclusion when he says: "*Lymph* is the fluid which, while it conveys certain substances to the blood, which come from the tissues, at the same time brings along with it the corpuscular elements out of which the blood-cells continually recruit their numbers." Bennet states that as the chyle progresses toward the thoracic duct it is found to contain a number of free nuclei, and that these in mammals may be observed to present the same size and bi-concave discoid form of the colored blood-corpuscles.

395. The blood-discs have a determinate life, and in the normal condition of the system are developed as fast as worn out. How long this life is we are unable to say, but judging from the disruption we see in the blood of the spleen and portal vein, and the amount of hæmatin set free and found in the excretions, we may conclude that their life is shorter than the formative cells. There is evidence, however, that it is not as brief as is claimed by some writers. For instance, Dr. Draper remarks: "It is sufficient to arrest our thoughts at once when we learn that for every beat of the pulse nearly *twenty millions* of these organisms die!" Judging from what we know of their waste by examinations of splenic and portal blood, and the length of time necessary to reproduce them, we may give them a vitality of some six weeks to two months. If we take the conclusions of Dr. Cham-

bers, that the duration of animal matter within the body is about equal to what is without the body, we will have to allot them a still longer period of life.

396. The most important *function* of the red corpuscles is the carrying of oxygen from the lungs to the tissue, and of carbonic acid gas from the tissue to the lungs. They may be likened to boats, freighted with a cargo of life to the tissues, and having a return freight of death, to be cast out with the expired air. They also contribute to the development of the other constituents of the blood, giving it such form as will adapt it to the nutritive process.

397. *Excess* of the red corpuscles is of rare occurence, and never to any very great extent. Experience has taught us to regard these discs as almost synonymous with life; when they are abundant and well formed, we expect to find a vigorous life, and an active performance of all the functions of the body. I do not think that the condition of excess exists where it will become necessary to reduce their amount, as was done in olden times by general blood-letting, and the employment of antiphlogistics, both of which accomplish this end.

398. *Defect* of the red corpuscles, on the contrary, is of quite frequent occurrence, and may be caused by any disease that occasions profuse discharges from the blood; by hemorrhage; by a deficient supply of food or disturbance of the digestive process; by a lesion of the lymphatic system, or by an impairment of the blood itself, either as a direct loss of vitality, or the oppression of effete matters. When the first causes are active, it becomes important to arrest such discharges, and then if the blood-making organs are active the full supply will soon be reproduced. We have already examined the relation that the digestive process bears to the formation of blood, and it will not be necessary to recur to it again. In this connection attention may be called to the well known fact that the administration of iron facilitates their renewal by furnishing their basis. Iron for this purpose, and the bitter tonics to improve the appetite and digestion, are the means in most common use.

399. The relation of the lymphatic system, especially the mesenteric glands, to the formation of the red corpuscles should not be disregarded. If the birth of these important constituents of the blood is in this system we may be able to influence it in certain cases. I am pretty well satisfied that we do influence it by the administration of that large class of agents called alteratives. Some of these possess an undoubted power in the formation of blood, and not to be accounted for by any influence they exert upon the digestive apparatus or the organs of excretion.

400. *Perversion* of the red corpuscles is seen in many diseases, and there can be no doubt forms an important element of them. Change of structure involves change of function and, as we have already seen, the function of the red corpuscles is indispensable to life. In some instances the impairment is in the power to carry oxygen and carbonic acid gas, and consequently the combustive process is feeble, and the blood is poisoned by retained carbon. In other cases they seem to have lost their vivifying power, and do not give that stimulus to tissue which is necessary for the performance of function.

401. The following alterations are noticed by Dr. Williams: "The *coloring matter* is evidently altered in some diseases, being much darker than usual, as in the worst forms of scurvy, in which the blood is said, by Mead, to be changed to a dark brown or green color; in the Walcheren and other malignant fevers, it has been described as pitchy black. In the worst forms of cachexia (or rather *cachæmia*), from malarious influence, generally found in conjunction with disease of the spleen, the blood is not only very poor, but also perverted in constitution, exhibiting various shades of purple, brown and even greenish colors. Some change seems to occur in congestive typhoid fevers, in which the blood-vessels become stained or dyed of a deep claret color; for this staining implies a breaking up and unnatural solution of the red corpuscles. Probably the occurrence of petechiæ and ecchymosed patches in these diseases is partly dependent on a similar change. The readiness with which the textures become stained in scorbutus, in jaundice, and albuminuria, and in secondary syphilis, seems

to indicate an altered state in the coloring matter of the blood; inflammations and ecchymoses in the skin are commonly followed by livid, purple, or copper-colored stains. The yellow tinge of the skin in yellow fever, occurring chiefly along the course of the large blood-vessels, the peculiar sallowness connected with diseased spleen and in chlorosis, and the dark discoloration around the eyes in the same diseases, apparently proceed from a change in the coloring matter of the blood, which causes it to escape from the vessels and tinge the skin, as in a part discolored by a bruise. The black matter of melanosis seems to be the coloring matter of the blood in an altered state, constituting a peculiar pigmentary matter; it is likewise so in the spurious melanosis of the intestines.

"Besides changes effected in the color of the blood, the red corpuscles are subject to alterations in their form, size, and other properties, effected through the influence of the medium in which they are placed. It was first observed by Hewson, that pure water causes them to swell, become globular, and burst; while saline solutions, containing more salts than serum does, make them shrink in size. These changes are now generally understood to arise from endosmosis and exosmosis; the saline matter drawing the water into or out of the little cell, which, with its contained coloring matter, constitutes the red corpuscle. It is highly probable that similar changes may take place in the living body, when circumstances greatly alter the proportion of saline matter and water in the blood. Such changes may possibly contribute to produce the serious symptoms, and even the sudden death, which have ensued on drinking a large quantity of water after great exertion. Has it also aught to do with the re-action and irregular excitement that sometimes occur after excessive losses of blood? Or with the symptoms of suffering which animals manifest on the instant when water is injected into their veins? Dr. Owen Reese has suggested that the remarkable diminution of the blood-discs in cases of albuminuria may be due to their destruction in consequence of the draining away of albumen from the blood, and its subsequent reduction to a very wa-

tery state; the same circumstance may also prevent their redevelopment from the chyle and lymph both in these cases and in chlorosis. In several cases of Bright's disease of the kidney I have observed the blood-discs to be jagged or crenate at their margins, and otherwise imperfect; and the same remark has been made by Simon, of Berlin, and others, and by Andral in a case of chlorosis. In one fearfully rapid example of albuminuria, which proved fatal in six days, with effusion of pus in the joints the day before death, I found the coloring matter dissolved in the blood-liquor after death, and scarcely any red discs remaining. There were also numerous pus globules in the blood. A similar total destruction of the blood-discs was observed in University College Hospital in the blood of a person who died of malignant scarlet fever with purpura. I have met with similar proofs of breaking up of the red particles, but to a much smaller extent, in acute purpura connected with jaundice, and in cases of disturbed function of the liver without jaundice. Is this due to the remarkable solvent power which small proportions of bile exert over the red particles, as noticed by Simon and others?"

COLORLESS CORPUSCLES.

402. The colorless corpuscles of the blood are very distinct from the red discs; and it is likely they have no relation to them. The colorless corpuscle is perfectly spherical in form, is without color, and nucleated, and bears no resemblance to the blood disc, other than it is of the same size. In health there is about one colorless corpuscle to three hundred red corpuscles, though in some diseased conditions they become very abundant. So closely do these bodies resemble pus-cells, that the most careful microscopic examination will not determine the difference. Virchow states that the only way in which they can be distinguished is, that one is within and the other is without the vessels.

403. *Leucocythemia.*—In certain conditions these colorless corpuscles are very greatly increased, so much so as to give the blood a whitish or milky color. In some of the most marked cases it

was thought that the blood was purulent. These white cells are developed in the lymphatic glands, and also in the spleen; and this condition, leucocythemia, arises from disease of one or the other. Virchow claims that "upon investigating where this curious change in the blood takes its origin, we find in the great majority of cases that it is a certain definite organ, which presents itself over and over again, with convincing constancy, as the one essentially diseased; an organ which frequently, even at the outset of the malady, forms the chief object of the complaints and distress of the patient—namely, the spleen." He also claims that in all the known cases but one was reported as benefited; in all the others the result was death.

ALBUMEN.

404. The albumen of the blood represents the histogenetic material, prepared for the nutrition of tissue. It is not yet certain that it furnishes all, as some have contended that the globulin was employed for the same purposes, but judging from what we know of the constitution of the blood, we may regard the seventy parts of albumen as wholly representing the tissue plasma of the blood. This is a protein body, possessing all the elements and in the exact form that it is found in the nitrogenized tissue, and it differs in no respect from the protein substances in the food, whether animal or vegetable, other than it is in a state of complete division—wholly *formless*.

405. In the constant renewal of tissue that goes on in every part of the body, it is each moment drawn upon, and portions removed; while at the same time it is just as constantly being replaced from the digestion of food. As heretofore noticed, all that is necessary to give the blood good albumen is, that the food be good, and the digestive process performed in such manner that there will have been a complete disruption of organized forms, without changing the arrangement of its elements. There is, no doubt, an added vitality to a slight extent, in that by contact with the blood it becomes more plastic, and is more amena-

ble to the formative force which is to mold it into the composition of the body.

406. An *excess* of albumen, like an excess of the red corpuscles, would give increased life and nutrition of tissue, and could hardly form an element of disease. It is possible that in some cases there may be an increased nutrition over that needed by the activity of the body—that is, a general hypertrophy—but this must be very rare.

407. *Deficiency* of albumen is of very frequent occurrence, forming an element in all diseases attended with exhaustion, and increase of waste over supply. Whenever, therefore, a patient loses flesh, *i. e.*, nitrogenized tissue, we will have reason to suppose a deficiency of albumen, unless there is evidence to show that the lesion is of the formative cells. When the albumen is deficient, there is occasionally dropsy, but this is most usual when it is also perverted. In *albuminuria*, or Bright's disease, this deficiency of albumen is very marked, and we not only have great loss of tissue, but an impaired circulation, and from this dropsy in the advanced stages of the disease.

408. Deficient supply of albumen can be remedied by the use of such medicines as act upon the digestive organs to restore the appetite and digestive power, at the same time giving the patient such restoratives as the blood may require, and a nutritious and easily digested food. As we have seen before, the albumen is sometimes drawn upon to furnish combustible material, which it does at very great loss; in such cases calorifacient food should be employed to such extent as to arrest this waste.

409. *Perversion* of the albumen is a constituent of several diseases, and of two I regard it as the principal element. We can readily see that if the processes of digestion and assimilation be impaired, through diminished vitality of the digestive and blood-making organs, including the blood itself, this protein plasma must suffer to some extent (261). Tuberculosis has its origin in an imperfect albumen in the blood, though still beyond this is the feebleness of formative power. If we examine the tubercle from the lungs or other portions of the body, we find it

derived entirely from the albumen of the blood. When normal albumen is exuded from the vessels, it is in the form of plastic lymph, which is organized into tissue, or breaks down into pus. Tubercle is the same material, but is only susceptible of a slight and feeble organization, or is not susceptible of organization at all.

410. As the vitality of the person becomes depressed by the continuance of diseased action, we find an increasing change in the albumen, becoming less and less capable of organization, or even of maintaining its form, until finally it breaks down as it is exuded. In a person of feeble vitality there is, doubtless, more or less of this imperfect material formed all the time, but the excretory organs being active the blood is freed from it as fast as formed, and it is only when, from still further loss of vitality, its quantity is greatly increased, or from derangement of the excretory organs that it is not removed, that we have tuberculosis.

411. To some extent scrofula is also dependent upon a lesion of this constituent of the blood; and in all of those chronic diseases where it is common to say the *blood is bad*—dyscrasiæ—it also forms an important element. In those cases there are two prominent parts to the treatment. First, to call into action the excretory organs, and remove all such material as will not form tissue, and second to place the digestive organs in good condition, and endeavor to get a good formation of albumen.

FIBRIN.

412. Fibrin is one of the smallest constituents of the blood, two and a half parts in a thousand, and yet it has been examined and written about more than any other one. Notwithstanding it has played so important a part in the pathology of the last century, there is less known of its uses than of any other portion of the blood. Physiologists have not yet decided whether it is albumen rendered plastic for tissue formation, or whether it is material undergoing retrograde metamorphosis. Draper regards it as a histogenetic material, while Zimmermann, whose opinion is indorsed by Dr. Bennet, regards it as effete material which will

be removed by the glands. Dr. Williams takes a middle ground, and regards it as forming the fibro-gelatinous tissues that have little formative power in themselves It is not very important how this question is decided, but I am inclined to regard it as a higher vitalization of albumen, fitting it for the use of the tissues. My reasons for this opinion are, that it is present in increased quantity during the repair of injuries; that it is increased to a certain extent in inflammations which require a reparative process, and even in chlorosis it is in large proportion from the need for tissue formation.

413. In the past it has been regarded as an evidence of inflammation, of an inflammatory condition of the blood, or of an excess in vital manifestations necessarily leading to destruction. It was not only regarded as an evidence of an inflammatory condition, but as one of the principal constituents of it, so that when present in increased quantity it was deemed necessary to remove it. The formation of clot, the buffy coat, cupped crassamentum, etc., are things of the past, and no one of the present day has the temerity to advocate the doctrine of Marshall Hall, that blood-letting was justified as a means of diagnosis.

414. Since Magendie proved so conclusively, that fibrin was not necessarily increased in inflammation, that it was often found in greatest excess in anemia and chlorosis, and that repeated bleedings always increased it, the subject of the change of quantity and lesions of fibrin have not been discussed so much. And since general blood-letting has ceased to be employed there are no means of determining its quantity and quality, and the subject of *hyperinosis* and *hypinosis* has been put upon the shelf with the obsolete lumber of the past.

FATS.

415. Fatty matter is in much smaller quantity in the blood than we should expect to find it, considering its important use in the economy. Still, regarding it as a combustible material, and the blood as the place where it is burned, it is continuously removed. If taken in excess of the need for present combustion,

there are tissues that remove it immediately from the current of blood, and store it up for future use. The cells of adipose tissue have the same origin as other formative cells, consisting of histogenetic material, and the fatty matter which they remove from the blood is simply contained by them. This tissue is ready-formed as a container at all times, and hence the rapidity of the removal of fat from the blood.

416. A certain portion of fatty matter is required for the nutrition of the brain, and chemists have found this to differ from other animal fats. There is no doubt but that it has the same origin, but we have no knowledge of the processes by which it is prepared for use.

417. As we have heretofore seen, a sufficient amount of calorifacient food is necessary to maintain the heat of the body. If this is not furnished by the food, the accumulated fat is drawn upon, and if both are lacking the histogenetic food and the tissues are burned. It is bad economy to use poor fuel for producing heat, and especially bad to use that which is expensive and scarce, hence we find that there is no waste so great as the burning of nitrogenized material in the body for the production of heat.

418. An *excess* of fatty matter is found in obese persons, and it is a matter of interest to learn why it is deposited in so large quantity, and how it may be influenced. It has three sources of supply, in fatty, sweet, and farinaceous food—fat, sugar, and starch—and in persons inclined to obesity such a diet will cause rapid accumulation; but in these persons the fatty tissues are in a very active condition, and it is possibly this, more than the supply of food, that gives rise to the condition. A strictly animal diet, with a sparing use of water, it is claimed, will reduce the tendency to obesity, and cases are reported in which a great reduction in weight followed in the course of some months' persistence in it.

419. *Defect* of fat in the blood exists in all cases of emaciation, as we have heretofore seen. If we regard the storing of fatty matter for future use, we find that some persons are naturally as deficient in this regard as the process is active in others.

There are many persons who could not increase such deposit an ounce, no matter what food they employed. In others we find that the deposit of fat is increased by a high temperature and quiet. We remedy a defect of fat in the blood in two ways: First, by the administration of such fatty matter as can be readily assimilated, cod-liver oil being that usually employed; and, second, by artificial warmth, removing the necessity of such rapid combustion.

SALINE MATTERS.*

420. The salts of the blood vary from six to eight parts in a thousand, and may be regarded as one of its most important con-

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* The following quotation from "Observations on the Blood," by Wm. Stevens, M. D., published in 1832, will be read with interest:—

"So long as the blood remains in the living system, and in active circulation, the whole of its ingredients are equally mixed and mutually in contact with each other; but when a part of this fluid is separated from the body, and allowed to rest, it loses its vitality; and, in proportion as this takes place, it begins to coagulate, generally in from two to ten minutes.

"The fibrin, the albumen, etc., are naturally solid, and, with the exception of the coloring matter, the whole of the solid ingredients of the blood owe their fluidity, not to the presence of a free alkali, but, as I believe, to the circumstance of their being held in solution by a *saline fluid*. While in the circulation, vitality and the incessant motion of the blood tend to prevent the occurrence of those chemical changes that would be fatal to life; but when a part of this fluid is drawn from the system, exposed to the air, and allowed to rest, it loses its living principle; and then those chemical changes are no longer prevented which are, in reality, the cause of coagulation. Consequently it is not the living principle, but the loss of its vitality, which is one cause of the sudden change which the blood undergoes when drawn from the body.

"When we add an acid to the drawn blood, this interferes with the agency of the saline matter, and the whole of the ingredients become solid; for, in this case, even the albumen coagulates, and then there is no separation. The fibrin, however, is less soluble in the serum than the albumen; but still, when we add immediately an extra portion of the muriate or the carbonate of soda, or any of the other alkaline salts that are natural to the blood, even the fibrin does not then coagulate, and the whole of the ingredients remain fluid. But when the blood is left to itself, without any addition, serum of the common strength does not prevent the coagulation of the fibrin, and then the blood separates into two parts.

stituents. The chloride of sodium, or common salt, forms the largest portion of this in man, and is continually supplied by the salt taken with the food. While common salt is the principal saline of the blood in man, it is said that the phosphates are in larger amount in carnivorous animals, and the carbonates in the herbivora. That these are essential to life is proven by the serious results that follow their partial withdrawal. In proof of this,

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"The serum is the saline fluid which contains the albumen in a state of perfect solution; and, so long as the blood is in active circulation, the fibrin also appears to be dissolved in the serous or watery part; but the fibrin is less soluble in this fluid. It is naturally solid, and when no longer agitated, as it is in the circulating current, it readily assumes its natural form. The coloring matter is the only ingredient which is not soluble in a saline fluid. When allowed to rest it mixes with the fibrin, and the union of these two agents forms the crassamentum, or solid part of the dead blood. This, as we all know, sinks to the bottom, and leaves the serum on the surface, perfectly free from any tinge of the red color.

"Coagulation is the result of these changes, and the first part of the process is the apparent solidity of the whole. This, however, is a deception; for the apparently solid mass contains a large proportion of fluid; but in proportion as the fibrin becomes solid it contracts, and in a short period the serum begins to be forced out, first on the surface, and then around the sides; a part of it covers the clot, and the rest of it occupies that space in the cup which is left by the contraction of the solid fibrin.

"In the act of coagulation a fine film forms on the surface of the stagnant blood. This film, however, is soon ruptured by the fluid in various places, and the serum appears first in drops; but as these increase in size they unite, and at last, after an interval of many hours, the whole of the saline fluid is forced out, and remains separated from the clot only by the fine film on the surface of the crassamentum.

"When we allow the blood to coagulate, and then, before the commencement of the separation, make an incision into the clot, when it is just firm enough to enable us to cut it with a knife, we find that it is at this period all equally red; that is, it is all red, so long as the salt serum is still in immediate contact with the whole of the coloring matter. But when we allow the coagulum to remain undisturbed, and examine these two portions of the blood (after the separation is fairly effected), we find that every particle of the saline matter has combined with the serum; and now that the internal or central part of the crassamentum is no longer in contact with this saline fluid, the whole of the coloring matter is perfectly black, except a thin stratum on the surface, which possesses a rich scarlet or arterial appearance.

"There are two causes which appear to be concerned in the product of this scarlet color on the surface of the clot. In the first place, the removal of the cause of the impurity from the exposed surface, by the oxygen of the air; in the second, the circumstance of its being covered

Dr. Paris states that he has witnessed the bad effects of unsalted fish; and the poorer classes in many districts sustain great injury to their health from an inability to procure this essential article.

"Lord Somerville gave an interesting account of the effect of a punishment which formerly existed in Holland. The ancient laws of the country ordained men to be kept on bread alone, *unmixed with salt*, as the *severest* punishment that could be inflicted

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and in contact with a saline fluid—for, without the agency of this, neither the removal of the impurity nor the addition of oxygen can produce the arterial tint, or even redden the color on the surface of the crassamentum.

"It is, I believe, a common opinion, that the arterial color of the blood is produced by the absorption of oxygen into this fluid. I shall afterward, however, endeavor to prove that this is not only an error, but one that has been the cause of great mortality in the practice of medicine. When oxygen is brought into direct or even indirect contact with venous blood, it instantly reddens the color. It is not, however, the absorption of oxygen which causes this change; for it is not by addition that this gas produces its effect in brightening the blood, for scarlet is the natural color of the vital current, and this it owes to another cause. I have ascertained, by numerous experiments, that all the acids blacken the blood, and my conviction is that carbonic acid, and not carbon, is the cause of the dark color in the venous circulation. Oxygen, however, possesses, as I shall afterward prove, a powerful attraction for carbonic acid; and when venous blood is exposed to the air, either in the lungs or out of the body, oxygen brightens its color, *not by addition*, but by *attracting* or removing the carbonic acid from the venous blood, and this becomes bright exactly in proportion as it loses that which had been the cause of its dark hue. In a high temperature the acid is rapidly removed by the oxygen; when this is effected the blood is purified, and instantly recovers its natural or scarlet appearance. Oxygen, however, is essential to life, for without this the heavy deleterious gas, which is the cause of the impurity in the venous circulation, would not be removed in the pulmonary organs. But the scarlet color exists in the blood independent of oxygen, or at all events, oxygen of itself can not produce either the red or the arterial appearance; for when we cover the crassamentum, when it first coagulates, with a layer of distilled water, or any other fluid which does not contain saline matter, the acid may be removed by the oxygen or absorbed by the water, but the color becomes darker than it had been before. On the other hand, when we immerse the black and saltless crassamentum in any clear *saline* fluid, the color instantly changes from dark venous to a bright arterial; and when the fluid which we use is sufficiently impregnated with saline matter, this change is produced *when we make the experiment, as I have frequently done, even in an atmosphere of carbonic acid.*

"When the crassamentum remains covered with its own serum, it re-

upon them in that moist climate. The effect was horrible. Those wretched criminals are said to have been devoured by worms engendered in their own stomachs."

421. The soda of the blood gives it its fluidity, and tends to preserve the form of the red corpuscles. To this is added the still more important function of enabling it to carry carbonic acid, as the presence of the normal amount of soda enables it to take up twice the volume that it otherwise could contain. As oxygenation is in direct ratio to decarbonization, and both to the

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tains for a time its arterial color; but when we add an extra portion of saline matter to the natural serum, the surface of the clot instantly becomes much brighter than it had been before—that is, so long as it was merely covered with its own serum, which was less impregnated with saline ingredients; or, when we cover the crassamentum the moment it coagulates with a clear but strong saline fluid, the color instantly changes from purple to scarlet.

"If we cut out a part of the red clot when it first coagulates, it is then, as I have said, all equally red. When we immerse this red clot in distilled water, it becomes black; or if we place this portion of red coagulum on a table, the serum escapes from the sides and lower part of the clot; while that part of the upper surface of the crassamentum which is left in immediate contact with the air, or even with pure oxygen, becomes black exactly in proportion as the serum falls down from the surface and escapes from the clot. Now, from this simple fact it is very clear that it is not the oxygen of the air, but the serum, or some of the ingredients in this fluid, which are the cause of the red hue of the coloring matter, and consequently of the red color of the blood.

"When we add a solution of any one of the neutral salts, even to the darkest venous blood, this increase of saline matter almost instantly reddens the color; and as soon as the carbonic acid is removed by the oxygen of the air the color of the whole becomes much more highly arterial than it is in blood from the same vein to which no addition has been made.

"When we leave the crassamentum of healthy blood completely covered with its own salt serum, it retains its arterial appearance on the surface for several days; but it soon becomes black when we take the crassamentum out of the serum, so as to expose its surface directly to the air. From this it is clear that oxygen is not the cause of the red color, for without serum it becomes black, even when in direct contact with the purest air. It is true that, in the process of respiration, after the acid is removed, there is a portion of air taken into the circulation; this, however, is to serve another purpose, and not to brighten the blood, for the color is changed before the air is attracted into the current."

"When we cut out a piece of the red crassamentum from healthy blood which has just coagulated, and immerse this in distilled water, the water

waste of tissue, we will see that both oxygenation and waste are to a certain extent dependent upon its presence in normal quantity.

422. The potash of the blood is employed in the formation of muscular tissue, and is said to be devoid of the above property, while the phosphate of lime is withdrawn for the formation of bone. It is not likely that phosphorus is withdrawn for the use of nerve tissue only in the form of phosphorized fat. If the potash and soda are antagonistic, as suggested by Dr. Williams, "as

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rapidly attracts the saline ingredients out of the clot. In proportion as this takes place the color changes, and in a short period it becomes perfectly black. From this we may infer that black is the natural color of the coloring matter, for it is only red so long as it remains in immediate contact with a saline fluid. When we take this black clot out of the distilled water, and expose it directly to the air, it remains black; or, if we immerse it in a jar of pure oxygen, the oxygen can now no more redden its color than it can change the color of the blackest ink. There is but one way in which the red color can be restored, and that is neither by air, iron, nor oxygen, but by restoring to the blood the saline matter which it has lost; and when we sprinkle or rub a small quantity of muriate or carbonate of soda, or any of the neutral salts, on the black clot, not merely the red, but a color that is highly arterial, is immediately produced; or when we make an artificial serum, by impregnating water with any of the neutral salts, and then take the black clot out of the clear fresh water, and immerse it in this equally clear saline fluid, it is immediately changed from black to a bright red color. When we take this scarlet clot out of the saline fluid, and immerse it again in distilled water, it soon becomes black; but when we remove it from this, and immerse it again in the clear saline fluid, it again changes to a rich scarlet; and this we can repeat, even with the same clot, as often as we please. Now, as these experiments prove that when the saline matter is withdrawn from the blood it becomes black, and when this is restored it recovers its arterial color, we may then, I believe, safely infer that the saline matter of the vital current is the true cause of the red color of the coloring matter, and of course of the red color of the blood.

"A clear fluid that is more impregnated with salt than common serum will brighten the color, even independent of the removal of the acid. This I ascertained by many experiments in an atmosphere of natural carbonic acid so strong that it was fatal to rabbits, etc., in less than three minutes. It is also true that acids, alkalies, electricity, poisons, but particularly those aeriform poisons which are, in reality, the remote cause of the malignant fevers, and, in short, everything that either decomposes or interferes materially with the agency of the saline matter, destroys the red and gives a black color even to arterial blood."

most probable that the phosphate of potash and chloride of sodium in the blood are constantly affecting each other's decomposition," it is a matter of great interest when salts of potash and soda are being so constantly exhibited as remedies. I am very well satisfied that it does make a great difference which we use, whether we employ them as restoratives, or for other purposes,

423. For every important function nature has made such perfect provision that the organism is not endangered by its arrest. Thus the need for food is provided for by a resistless desire—appetite and hunger—for water, thirst—for respiration, an automatic movement without the influence of the will, and in this humble element that we are now considering, an appetite that will be supplied whatever inconvenience it may occasion. So that in health, when food is being constantly taken, we have no reason to suppose that there is ever a deficiency, but when disease attacks a person and the appetite is lost, the desire for common salt is sometimes lost with it, and we then have deficiency. There may be deficiency at other times, and we have occasionally the evidences of it, but are unable to see why the material supplied so freely with the food should not be appropriated by the blood.

424. *Excess* of the salts of the blood is an element of many acute and some chronic diseases. I find it occasionally in all the fevers, intermittent, remittent, continued, and eruptive, also inflammatory diseases. As we are not able to analyze the blood to determine it, we must draw the evidence from certain general symptoms. I rely upon this condition: the tongue uniformly of a *deep red*, either smooth and glossy or covered with a brownish or dark sordes. In typhoid or typhus fever such a tongue will be recalled as very common, and as indicating a severe type of the disease. In such case it will be observed that the waste of tissue is very rapid, the patient becoming very much emaciated. Notice the correspondence between this symptom and the views set forth in (411), and by Dr. Stephens in the accompanying note. The waste is so rapid as to endanger the life of the person, and frequently the most available means is to arrest this process.

425. In such cases as this I always give acids, and I find im-

mediate and permanent advantage from their use. I usually prescribe *dilute muriatic acid*, though my friend, Prof. King, thinks well of acetic acid, and usually orders cider for his patients. In acute diseases with these symptoms, we find that the waste of tissue is lessened, and at the same time the acid exerts an influence upon the stomach and digestive apparatus very favorable to digestion.

426. In many chronic diseases a like condition exists, and the physician is frequently at a loss to account for the great emaciation, and more so for its continuance despite the free use of bitter tonics and iron, and a nutritious food. The evidences of alkalinity are not as well marked in these cases, but yet there will be found the same *deep redness* of the tongue and mucous tissues. What is the rationale of the action of the mineral acids in arresting *night-sweats?* I have never seen an explanation, and yet I think we have it here; they stop night-sweats because they stop waste of tissue, and that by diminishing the excess of soda in the blood.

427. In chronic diseases having the symptoms above-named, we can sometimes prescribe potash with advantage. Even in phthisis, with night-sweats, we find that chlorate of potash has been used with marked advantage, and in many other affections *iodide of potassium* in small doses is said to act as a tonic, improving the appetite and increasing the weight of the body.

428. If these are facts, and the reader will be enabled to verify them by observation, it will be admitted that it will make a great addition to our therapeutics. For my part I am so thoroughly convinced, by a large experience extending over a score of years, that I make my diagnosis and administer acids with as much certainty as anything I know or do in practical medicine.

429. *Defect* of the salts of soda I diagnose by the broad pale tongue, with a pasty-white or yellowish coat; occasionally in typhoid diseases the coat may assume quite a brownish tinge, yet the pallor of the mucus tissues is characteristic. Associated with this condition of tongue, it will be observed that though there is no appetite, and no food is taken, yet the waste is re-

markably slow—emaciation does not progress as in ordinary cases. Where the condition of the tongue named is very marked, the circulation is feeble, and the temperature is not unfrequently lessened, and there is coldness of the extremities.

430. This condition I deem so well marked that it can not well be mistaken. The pallor of tongue and mouth, white pasty tongue, tendency to congestions, deficient waste, deficient generation of heat, and disgust for food, is a group of symptoms that must impress itself on the mind of every observer. It will be noticed that this corresponds exactly with the theory named, and pretty closely with the quotation from Dr. Stevens. Such symptoms we find in almost every form of acute disease, whether fever or inflammation, and I feel very certain it, like the preceding, is one of those conditions that gives disease its fatality.

431. I notice the evidences of this defect in many chronic diseases. The patient feels badly, and does not know what is the matter; indeed, there are no prominent symptoms to guide the physician. Though the appetite is poor, and the patient unwell for a length of time, he does not seem to lose flesh. The surface, however, has a doughy appearance, his extremities are cold, and the entire soft tissues seem to have lost tone. If we examine this person's tongue we will find it broad, sometimes enlarged in every direction; pale, in severe cases pitting where it comes in contact with the teeth, and covered to a greater or less extent with a pasty-white or yellowish coat. This coat is always more marked at the base and along the center of the tongue, and in the morning when he rises.

432. In both the acute and chronic cases, if these symptoms are marked, we find that the ordinary remedies that control such diseased action have but little effect, at least no permanent benefit follows their use. In acute diseases, the fever persists, the secretions are locked up, there is disturbance of the nervous system, and continually increasing prostration. It was remarked, in olden time, that increasing prostration without corresponding loss of flesh was a very grave symptom. So in chronic disease, the

appetite and digestion remain poor, the secretions sluggish, and the circulation feeble, no matter what may be employed.

433. In acute diseases, when I recognize this condition, I order a couple of drachms of *bicarbonate of soda* to a six ounce glass of water, or the strength that is pleasant, and placing it at the bedside let the patient take as he chooses. In almost every case it will taste well, and leaving a pleasant impression in the mouth, the patient sips it frequently, and in many cases will require its renewal three or four times in twenty-four hours Usually by the second day there is a decided amendment in all of the symptoms, the stomach is in better condition, and can commence to take small portions of food. Generally it needs to be continued, for three or four days, and then by giving the patient *salt* with his milk or other food, there is no recurrence of the symptoms.

434. When there is a septic tendency either in the blood or locally in the contents of the stomach and bowels, I use the sulphite of soda in place of the bicarbonate. Not unfrequently we find a derangement of stomachic digestion attended with the broad, pale tongue, with a pasty coat in center and on base. The patient's tissue has a doughy look, and he feels badly, though he can hardly tell where. In such cases there is not unfrequently a sluggish action of the bowels for a time, followed by diarrhœa. In this case *sulphite of soda* is almost specific. In chronic diseases, when these symptoms are present, I administer soda in some of its many forms, and I always expect the direct influence that I have named.

PHOSPHORUS.

435. Though but a small constituent of the blood, we find it in combination with potash, with soda, with lime and magnesia, and with fatty matter. These combinations are so constant and uniform that we can not but regard phosphorus as a necessary element of the blood as well as of the brain. Of course, the principal part of the phosphorus taken as food is deposited in the bones as phosphate of lime, and it is principally with the free portion that we are concerned.

436. To the nervous centers phosphorus is as essential as iron is to the blood, and whenever we have great nervous action and waste, it is found in excess in the urine. As before remarked, it is probable that the phosphorus employed by the brain is taken from the blood in combination with fat; for muscular structure, in combination with potash; for bone, in combination with lime. In the adult brain it forms 1 80 per cent., in infants but 0.80, and in idiots but 0.85, showing that the function and activity of the organ are dependent to some extent upon this element. Of the *ash* of muscle it forms 36.6 per cent., the potash being 40.2 per cent. Its combination with lime seems so strong that it is rarely disrupted, no matter how great the need of the nervous or muscular tissues; and in food it has to be supplied in other than this form or the system suffers from its defect.

437. We have now to bring clinical observation to bear upon the subject, and we may possibly unravel more of this tangled thread. It is claimed that the *hypophosphites* are among the most important restoratives in many diseases where there is great loss of strength. I am satisfied that in diseases attended with exhaustion of the brain, the administration of phosphorus in such form that it can be readily appropriated, is an important part of the treatment. It is also useful in certain affections where the muscular tissue is involved, especially when debilitated, improving nutrition and giving greater irritability of muscular fiber.

EFFETE MATTERS.

438. The effete material is found in the blood in very small proportion, since it is being continually removed by the excretory organs as fast as formed. Were this not the case, the blood would soon become so loaded with it that it would be incapable of performing any of its functions. The examination of this material is rendered very difficult, from its small quantity in the blood, but principally by the fact that, being of the same composition of the blood, we have to examine it where that fluid is also dead and undergoing change. Its direct examination, therefore, yields

no results, whether the examination be physical or chemical, and we are therefore forced to the observation of facts during life, especially during diseased life, to determine those changes of the blood which are produced by the effete material. We have already noticed that the blood was extremely sensitive to impressions, and in that plastic condition where it could be influenced by any active force coming into contact with it, whether it was formative or destructive. As we see it yielding to the influences of every living cell, rapidly taking form and organization when the formative force is active, so we see it influenced by bodies in which the chemical force is active, and yielding as readily to this force as it did to the other.

439. When once set up the forces tending to disintegration are active, and sometimes remarkably strong, and they possess the additional property of transforming the material that they influence into a new center of action against other parts. This effete matter does not usually possess this disintegrating force, for it is rapidly changed into material fit for excretion, and during this time it is wholly controlled by the conservative forces of the body. When it does possess it, it is in varying degree, frequently feeble, and having a slow and but a slight influence, and in exceptional cases extremely rapid and powerful, breaking down the blood, and causing death in a few hours.

440. Liebig describes this action, when speaking of poisons and miasms, as follows: "There is a peculiar class of substances, which are generated during certain processes of decomposition, and which act upon the animal economy as deadly poisons, not on account of their power of entering into combination with it, or by reason of their containing a poisonous material, *but solely by virtue of their peculiar condition.*

"In order to attain a clear conception of the mode of action of these bodies, it is necessary to call to mind the cause on which we have shown the phenomena of fermentation, decay, and putrefaction to depend.

"This cause may be expressed by the following law, long since proposed by *La Place* and Berthollet, although its truth with

reference to chemical phenomena has only lately been proved: '*A molecule, set in motion by any power, can impart its own motion to another molecule with which it may be in contact.*'

"This is a law of dynamics, the operation of which is manifest in all cases in which the resistance (*force, affinity, or cohesion*) opposed to the motion is not sufficient to overcome it.

"We have seen that ferment or yeast is a body in a state of decomposition, the atoms of which, consequently, are in a state of motion or transposition. Yeast placed in contact with sugar communicates to the elements of that compound the same state, in consequence of which the constituents of the sugar arrange themselves into new and simpler forms—namely, into alcohol and carbonic acid. In these new compounds the elements are united together by stronger affinities than they were in the sugar, and therefore, under the conditions in which they were produced, further decomposition is arrested.

"From the foregoing facts it follows that a body in the act of decomposition (it may be named the *exciter*), added to a mixed fluid containing its constituents, can reproduce itself in that fluid exactly in the same manner as new yeast is produced when yeast is added to liquids containing gluten. This must be more certainly effected when the liquid acted upon contains the body by the metamorphosis of which the *exciter* has been originally formed.

"It is also obvious that if the *exciter* be able to impart its own state of transformation to one only of the component parts of the mixed liquid acted upon, its own reproduction may be the consequence of the decomposition of this one body.

"This law may be applied to organic substances forming part of the animal organism. We know that all the constituents of these substances are formed from the blood, and that the blood, by its nature and constitution, is one of the most complex of all existing matters.

"Nature has adapted the blood for the reproduction of every individual part of the organism; its principal character consists in its component parts being subordinate to every attraction. These are in a perpetual state of change or transformation, which

is effected in the most various ways through the influence of the different organs.

"Now it is a well known fact, when blood, cerebral substance, gall, pus, and other substances in a state of putrefaction, are laid upon fresh wounds, vomiting, debility, and at length death, are occasioned. It is also known that bodies in anatomical rooms frequently pass into a state of decomposition, which is capable of imparting itself to the living body—the smallest cut with a knife which has been used in their dissection producing, in these cases, dangerous consequences."

After speaking of the *sausage* poison frequently met with in Germany, he says:

"It is impossible to mistake the *modus operandi* of this poison, for Colin has clearly proved that muscle, urine, cheese, cerebral substance, and other matters, in a state of putrefaction, communicate their own state of decomposition to substances much less prone to change of composition than the blood. When placed in contact with a solution of sugar, they cause its putrefaction or the transposition of its elements into carbonic acid and alcohol.

"When putrefying muscle or pus is placed upon a fresh wound it occasions disease and death. It is obvious that these substances communicate their own state of putrefaction to the sound blood *from which they were produced*, exactly in the same manner as gluten in a state of decay or putrefaction causes a similar transformation in a solution of sugar.

"Poisons of this kind are even generated by the body itself in particular diseases. In small-pox, plague, and syphilis, substances of a peculiar nature are formed from the constituents of the blood. These matters are capable of inducing in the blood of a healthy individual a decomposition similar to that of which they themselves are the subjects; in other words they produce the same disease. The morbid virus appears to reproduce itself just as seeds reproduce seeds.

"The mode of action of a morbid virus exhibits such a strong similarity to the action of yeast upon liquids containing sugar and *gluten*, that the two processes have been long

since compared to one another, although merely for the purpose of illustration. But when the phenomena attending the action of each respectively are considered more clearly, it will in reality be seen that their influence depends upon the same cause.

"In dry air and in the absence of moisture, all these poisons remain for a long time unchanged; but when exposed to the air in the moist condition, they lose very rapidly their peculiar properties. In the former case those conditions are afforded which arrest their decomposition without destroying it; in the latter all the circumstances necessary for the completion of their decomposition are presented."*

441. I have given the above quotation to show the nature of the facts that have accumulated, and which we may use in further investigations; and also the laws by which organized bodies influence one another. When we attempt to explain why this influence is greater at one time than another we fail, and we have to remain satisfied with the simple fact that at certain times the *putrefactive* influence is very feeble, and at other times very strong, and between these every grade of activity. There are certain atmospheric conditions which influence this, and some of these we know. We know that warmth and moisture are favorable to it, and that cold and dryness are unfavorable. There are also changes in the oxygen of the air, one of which resulting in *ozone* gives it a greatly increased activity; and if we know of one giving increased activity, we may conclude it probable there may be another giving it less activity. It is true this is altogether theoretical, but we have the broad and well-established fact that there are certain atmospheric changes imperceptible with our present means of examination, but which have the power of generating and propagating the most powerful epidemic influence.

442. This subject may be profitably considered in two divisions: first, as to the influences from material generated within the system and retained in the blood; and second, as to the influence of vegetable or animal material undergoing decomposition when introduced from without.

443. *Impairment of the Blood from Retained Secretions.*—We have already seen (330) that the simple presence of the excretions in the blood, in increased quantity, impaired all the functions of that fluid, and that too when it was in such form that it could not influence adjacent matter in the manner that has just been described; but when its metamorphosis was checked, then it became more potent for harm, of course depending upon the state in which it was retained. It is the form in which the material is retained that gives character to diseased action rather than the material itself, though both are injurious.

444. Take the very common case of disease, cold, acting alike on several persons who, in their habits, methods of life and all their surroundings, are in similar condition. In the one case it will produce but the symptoms of a simple cold, in an other of an evanescent fever, while in a third the fever may assume quite a severe type. In the first instance the arrest of secretion was but temporary, and the material retained possessed no power to influence the blood; in the second case it possessed this influin small degree, and in the third case in marked degree.

445. Idiopathic inflammation, in nine cases out of ten, arises from *cold*, and what is this cold but retained excretion? We have no reason to suppose that the slight disturbance in the distribution of blood, could irritate the ultimate tissue of an organ to such extent as to produce inflammation. We can test this very thoroughly and very easily; for we can, by pressure on arteries and veins, shut off the current of blood to a part, and retain the blood in a part, and yet inflammation never follows. Though a derangement of the circulation is a prominent incident in the inflammatory process it is never a cause of it. What then is the cause? I claim it to be retained excretion, in the active form described by Liebig, and it is the influence of this upon the cell-growth of a part that gives rise to the process.

446. The evidence I adduce to prove this proposition is, first, that inflammations, when not the result of direct injury, *always* follow arrest of excretion; second, that a re-establishment of secretion early will frequently stop the inflammatory process in

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its early stage, and, third, that an inflammation always terminates by a re-establishment of the excretions. We might suppose that the retained excretion would arrest the process of cell-development, or more likely accelerate it, and thus necessitate the inflammatory process to remove the dead matter, but this influence could not be general without causing speedy death. We have to concede that some one part was more susceptible to the influence than other parts by a depression of its vitality, and in consequence of this want of resisting power it yielded to the influence of the material.

447. The disease we call *fever* bears a very close relation to inflammation, and though there is no specific lesion of tissue, yet the entire lesion is, to a slight degree, in the same direction. If we trace the advent and progress of a fever from cold and retained excretion, we will observe first a general exhaustion, when in the other case there was a local one. The prominent influence is upon the nutritive processes from the blood. Digestion is impaired or arrested, blood-making is also impaired or arrested, and cell-de-development and renewal of tissue are retarded or arrested. As all action in the animal body is dependent upon metamorphosis of tissue, we will find the body exhausting itself by the excited action of fever, without food or the power of repair. As secretion and innervation are vital processes, depending upon the production of secreting cells in the one case, and formative cells in the other, both of these functions will be impaired by the arrest of supply and the irregularity of other functions. This would give simple fever.

448. If now we regard the important change in the effete matter, by which it is given the power to influence other material of similar kind, or containing its constituents, we can see that every process will suffer still more. It is true that the blood is thus impaired from this cause, and that occasionally the impairment continues to complete death of the fluid. We may thus see how fevers, from seemingly the same cause, may be evanescent, or severe and of considerable duration.

449. We may also draw some conclusions as to a rational therapeutics in such a case. There is no fact plainer than that if a fever is produced by retained excretions, the sooner these are removed the better, so that the re-establishment of secretion becomes one of the most prominent indications of treatment. Yet we have seen, that it was not so much the material retained as its state that gave intensity to the fever—that this gives it both duration and danger. Therefore, as it is not possible to re-establish the secretions at once, we wish to employ such means as will modify this destructive influence.

450. Those remedies that control the circulation have an important influence in this direction, as the destructive process in the blood is in one class of cases in direct ratio to the rapidity of the circulation, and in the other case to partial *stasis* of blood. To control a rapid circulation, and to see that the blood circulates *equally*, and does not stand still in certain portions of the body, are very important elements in treatment. There are certain medicines that influence the putrefactive process; some that retard and others that increase it. The first class—*antiseptics*—are important in those cases in which the tendency to rapid decomposition is marked. In speaking of the salts of the blood, I named the symptoms that governed our selection of a saline, as *sulphite of soda*, or the mineral acids, as muriatic acid: both of these arrest or modify the destructive process.

IMPAIRMENT OF THE BLOOD FROM THE INTRODUCTION OF DECOMPOSING MATTER FROM WITHOUT.*

451. In the quotation from Liebig, the action of decomposing animal matter on the living body was described, and it was found to set up a similar process of putrefaction. The virulence of such

* ***Cause of Fever.***—"There is every reason to believe that one of the chief exciting causes of these fevers is a poison generated by decomposing ***organic matter,*** and received into the body from without. To judge

material varies in different cases, in some being but slight, and in others extremely active. We have the most marked examples of this in dissecting-room wounds; but in some subjects the putrefactive process is such that a cut is attended with most dangerous results. These poisons are denominated malarial, and we divide them into vegetable and animal, both giving rise to fever more frequently than to inflammation.

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by its effects, it seems to be widely diffused through the air, especially in the neighborhood of its origin in the air of sewers, putrid marshes, and crowded human habitations. If you are readers of popular sanitary literature, you are probably crop-full of the accumulated and *decies repetita* evidence of this fact. You are tempted to ask how it is, if the poison is spread so broadcast, that everybody does not get poisoned. You will wonder why it should get into the body of this boy, while you, really much more exposed to it, escape. But remember, there are two things necessary to poisoning—not only the poison, but a person apt to be poisoned. And, in point of fact, the latter is the most important element in the transaction. It is only on a predisposed body that a morbid poison acts. Most likely we are all constantly taking in minute doses of the poison which is the exciting cause of these continued fevers, and can digest, oxydize it, or otherwise render it harmless, under ordinary circumstances. But should some epidemic influence or exceptional deficiency of vitality rob us of the power of doing so, then we suffer the effects, and have typhus or typhoid fever, as the case may happen to be. There was reason enough for this boy being the victim, while others escaped, shown in his recent rapid growth and in his strength being overtasked by his work. The exhaustion of vitality allowed the poison to do its work.

"Besides this purely foreign mode of generation of the poison, it would appear capable of being produced within the body itself—out of its own substance—idiopathically. At least such a closely similar train of phenomena follow, where an external origin would seem a forced interpretation of nature, that we can hardly help coming to the conclusion I have stated in the last sentence. Thus a typhus state follows severe and disorganizing wounds, where all noxious foreign influences have been cautiously shut out; and mere climatic agencies, such as the unwonted heat of the sun, overwork, chills, damps, and especially a combination of these circumstances, will bring on the well known 'febricula,' perhaps of only a few days' duration, perhaps protracted into, or (as some word it) 'changed into,' a regular typhus.

"I speak of the exciting cause of fever as of a material ponderable substance for the sake of convenience. But I do not wish to exclude the possibility of its being an immaterial power or force, like light, heat, electricity and sound, are held to be. If it be so, it is, like them, associated with ponderable matter, and becomes known to us only by means of *such* association. We speak of a thunder-cloud causing certain phe-

452. Before considering these two varieties, it will be well to establish the fact that fever may arise from such a poison, and examine the steps in its production. The most familiar example, as well as the most distinctive in all its features, is inoculation with small-pox. Here we have an animal material produced from the body; we place a minute portion beneath the epidermis, and satisfy ourselves that it gains entrance into the blood. We

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nomena, although we know it is the electricity of the cloud which does so; of the sun burning us, when we mean the heat of the sun; of a cannon deafening us, when we refer to the vibrations of the air acting on our ears. And so we may speak of the poisoning power as a part of that modification of matter to which it is joined, in spite of that modification of matter possibly existing in a similar form (chemically speaking) without being joined to it.

"Observe how slowly the power acts in some cases. Our patient is upward of five weeks ailing before any of the distinctive features of his fever show themselves, and then they creep out one by one. The time is not usually so long, especially during epidemics, but you may detect it in the history of almost every case. And you ought to notice it, because from some systematic works you might be led to thinking that a continued fever was easily to be measured by days and hours from the very moment of invasion. This is impossible in practice, and would be of little use were it possible.

"I rather incline to think that the most usual path by which the virus enters is the digestive canal, in cases where it is begotton of decomposing organic matters foreign to the body. It is probably mixed with the saliva and carried down to the stomach, where it possibly may increase and multiply in the gastric mucus. During severe epidemics, it has been observed that those who smoke or chew, especially if they spit out the saliva instead of swallowing it, are less liable to be attacked. And at an early stage, even after the virus had begun to act upon the system, the fever may be stayed by emptying the stomach, and thus preventing the whole dose from being taken up. Those who have watched my practice will have witnessed several instances of the success of this treatment; they will have seen the fever cut short, and convalescence entered upon immediately, with its characteristics of painless weakness and emaciation gradually passing away.

"When the poison has once gained admission, and is diffused by means of the circulation through the system, its effect is to destroy the vitality of a considerable amount of the organic living matter with which it comes in contact. The destruction is interstitial, not local; I mean it does not kill wholly a certain spot which it touches, like sulphuric acid, but it kills only certain constituents of the tissues. The destruction is also partial, not entire; the organic matter is by no means utterly disorganized, but only brought down to a less vital, less organic condition. It may be traced easiest in the changes found in the medium by which

do no injury to the part that is not shortly repaired, and the nervous system suffers no injury, and for the first week the poison is in the blood, and acts only upon it. The first noticeable influence is, that the person feels weary, his appetite is impaired, digestion is deranged, the excretions are partly arrested, and a real debility makes itself manifest. The symptoms all point to a lesion of nutrition from the changed condition of the blood; for,

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it is diffused. The blood, the common thoroughfare for distribution of good and evil to the tissues, is seriously changed. If you examine it under the microscope, you will find that the normally shaped red discs are diminished in numbers, as compared with what pathologists call 'melanosed' corpuscles; that is to say, dying or dead discs, shriveled and small, of a dark color, with black specks in them, and with gimped edges. In bad cases these are unable to range themselves in rolls, as healthy blood does when it coagulates: they seem to have scarcely any attraction for one another, and lie in amorphous heaps; they dissolve early in the serum, and form with it a red fluid. You may trace this dissolution in the dusky stain which the blood communicates to the skin in typh-fever.

"The poisoning apparently goes on very gradually in some cases, and quicker in others. You heard from this boy that he was five weeks ailing before he gave up work. There was an imperfect renewal of the body, shown by languor after exertion, and by loss of appetite or deficient demand for new material. But destructive assimilation was not checked, there was no impediment to the carrying off of the effete tissues by excretion. It may be that in a great many cases the disease, the partial death, stops here, the destroyed tissues and their destroyer together are disorganized, are reduced to their elements, and pass away. The idea is incapable of proof, but it would account for a vast number of those mysterious languors, unclassified, unnamed, and often unpitied, which distress patients and puzzle doctors.

"It is a characteristic of this sort of virus to poison mainly the nervous system. The fevers it produces get their name from thence—*typhos*—equal a smoke or mist overclouding the instrument of connection between mind and body. In no other diseases of equal curability is it so much affected. When, therefore, the poisoning has reached a certain pitch, and that not a very high pitch, early in the disease, the nervous system takes notice thereof, and expresses itself in its most common mode of taking notice of partial death, namely, by a shivering fit. Any severe injury to the body, a stretching of fibrous tissues, an operation, the fear of an operation, the absorption of destructive drugs, such as antimony for example, will cause more or less of a rigor in proportion to the sensitiveness of the individual. And thus also in zymotic fevers, when the interstitial death of the neural constituents of the body arrives at a certain degree, there follows a rigor. This rigor recurs from time to time at uncertain intervals, but generally about once a day, and most commonly in the evening, as the mother remarked in the case which forms the text of my lecture.

as we have seen previously, activity of function is dependent upon formative power in the development of new tissue.

453. As the poison continues its influence, the debility and the failure of functional activity increase. The circulation is not as vigorous and as free as before, and there are evidences of impairment of the nervous centers, manifested by headache, by pain in the back and various parts of the body, and by a feebleness

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"Then commences another symptom of partial death—pain. This boy described his head, his limbs, and his back, as aching all at once. That is to say, wherever there was most tissue with sensitive nerves in it, there was found pain, indicating the diseased state of that tissue. Now this aching is a symptom of the earlier rather than of the more advanced stages of typh-fever; not because there is in the latter less death, but because then the nervous system becomes partially dead too, and does not feel so acutely, while in the former it retains most of its normal sensibility.

"Observe that our patient tells us of nausea and loss of appetite, which diminished the food eaten—of vomiting, which rejected the greater part of that diminished food—and of diarrhœa, which carried off the remainder scarce digested at all. Yet in spite of all, the amount of solid matter passed from the kidneys is fair; the specific gravity of the fifteen ounces of urine passed in the twenty-four hours is 1.020, which is a good deal for a person not in strong health. The metamorphosis, therefore, of the worn-out tissues into urea and salts is active; there is a continuous destruction of them in spite of the defective supply. This goes on so long as the poison lasts in the body; but when it is got rid of the destruction ceases; no more of the tissue is metamorphosed than is required to make room for new material, and the specific gravity of the urine falls during convalescence. This may take place very suddenly, as in the instance I gave you of a fever cut short by an emetic, but in general the alteration is more gradual.

"I have mentioned the amount of urea, large in proportion to the nutrition, contained in the urine of typh-fever, which is rendered evident by its high specific gravity. There is also an increase very evident to the naked eye in another constituent of some importance, the colored organic material, which gives the secretion its ordinary hue. You saw how dark this boy's water was, and how deeply it stained the vessel from which I poured it on a piece of white linen. We have great reason to think that there is a close alliance between this substance and whatever it is which gives the red tint to the blood discs, and that its excess depends on excessive destruction of those important little living particles.

"The sulphuric and phosphoric acids, combined with bases which form a necessary part of urine, do not in fevers follow the lead of the urea; their amount is less than in health. Whether this is due to the destructive metamorphosis taking less effect on the chief tissues containing sulphur and phosphorus, than it does on the blood and muscles, is doubtful. Dr. Parke *suggests that* perhaps a third of the normal sulphates and

of innervation in the performance of any act. Finally this influence culminates in a greatly impaired circulation, in which the blood fails to reach the surface and extremities freely, in which there is deficient oxydation and production of heat, and in which there is great prostration of the nervous system. This is called a chill, or the cold stage of a fever, and we will realize the exact nature of the phenomena and the producing cause if we examine it still further in those cases in which it proves fatal. As time passes and the influence deepens, the surface becomes really cold,

phosphates of the urine are derived directly from the food, and not from the metamorphosis of tissue; and therefore that their diminution in typh-fever may be owing to the starvation, while the amount which still remains represents a fair proportion of destruction.

"The chlorine, in the shape of chloride of sodium, is also in small quantity, but not so deficient as to lead us to suppose that the metamorphosis of the chlorinated materials of the body does not go on, or that there is retention of them in the fluids. The great quantity of chloride of sodium taken as food, and directly mixing with all the fluids, again brings in difficulty. And another is thrown in our way by the frequency of intercurrent pneumonia, which itself causes a retention of the chlorides naturally excreted from the kidneys. This youth, for example, has a little pneumonia, and we could not therefore say if absence of chlorides in his case were due to that inflammation or to typh-fever. In other cases our impediments to knowledge are diarrhœa and colliquative sweating, which carry off chloride of sodium.

"The diarrhœa so frequent a companion of continued fever is a further evidence of death in the blood. Let the fluid fever stools be set aside in a tall glass, and you will see them shortly separate into two parts, the higher one a half-transparent serum in which float epithelial scales and crystals of ammonio-magnesian phosphate; the lower stratum a greenish-black flocculent precipitate. This last has no smell of bile, nor is bile to be found in it by chemical tests; but it contains broken-up blood-discs, and a great quantity of dark, granular coloring matter; it is just like blood altered by the secretions of the bowels. And very often when you let the stools separate in this way, and look at them by transmitted light, you will see a visible sanguineous tinge in them, and blood mixed with mucus is visibly passed from the bowels. Blood, too, is not unfrequently spat up with the mucus from the lungs, and drips from the nose; and in bad cases the dried up mucous membrane of the mouth cracks, and exudes the sanguineous serum on the surface of the tongue, producing the 'dry, brown tongue,' characteristic of severe fever. All these prominent symptoms call your attention to the interstitial death, the lessened life of the body.

"The increased heat in fever is to a careless observer rather adverse to the doctrine which I have advanced, that all disease is an evidence

and, shrunken from the enfeebled circulation, the patient becomes dull and careless about his condition, and gradually passes into that unconscious state known as coma. Hour by hour the power of the heart is enfeebled, the blood that fails to reach the surface stagnates in internal parts, all functional activity is arrested; the skin, kidneys, and bowels, and the brain and spinal cord, have no influence upon the body. Finally, we notice a marked change in the blood itself; it not only circulates feebly, but it decomposes in the vessel and gives rise to discolorations of the surface,

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of diminished vitality. And in truth it requires some thought to see why it is not a conclusive objection. But an answer to the idea of an augmentation of heat being necessarily an augmentation of life is afforded by the fact of many recorded instances of the increase of corporeal warmth having taken place in corpses actually after full death; so that, discarding at once the notion of its being a proof of vitality, we may try and trace what causes, really rather to be associated with death, may give rise to it in the cases under our eye.

"In the first place, in fever you have a diminution of the evaporation which takes place from a healthy skin, and which acts as a powerful refrigerator, as any physiologist who has perspired knows full well. The dormant dry skin does not do its cooling office. Then in the second place, there is a much larger quantity of dead matter to be evacuated, and the destructive metamorphosis of the dead matter, the semi-vital chemical destruction, raises the temperature, as all chemical solutions do. Whenever metamorphosis is rapid the temperature is raised. But this metamorphosis alone, this passage of living into inorganic matter, can not be called an increase of life, inasmuch as it indicates an advance of death. It is necessary, may be, to the removal from the body of poisoned ingredients, and is so far an advantage, but still it is an indication of the quantity that is poisoned. Such are some of the most prominent consequences of the typh-poison in the human body.

"You may call to mind very likely, warnings I have given you against the old humoral pathologist's doctrine of a *materies morbi*, which was looked upon as the disease, and which he thought he had done his duty by endeavoring to eliminate. 'Surely,' you will say, 'this which you have been describing is a most typical *materies morbi*; if I evacuate this, I cure the disease.' Not so fast—the bullet which enters the soldier's ribs is a *materies morbi*—have you cured the disease when you have extracted it? Nay, more—suppose the bullet passed right through the chest and went out on the other side, would you consider the disease gone? No; the typh-poison is not the disease, any more than a bullet, or sulphuric acid, or opium is a disease, though each may be a material cause of disease. The partial death which these agents cause is the disease—is that which requires to be treated, and which must be the chief point for the physician's consideration."—*Chambers' "Renewal of life,"* pp. 88–96.

and with this death of the blood occurs the death of the whole body.

454. But it is seldom that it thus overpowers the vitality of the blood; and, having gone as far as the development of the chill, the *vitality* of the entire system is aroused for its opposition and final removal. All experience goes to prove that there is a surplus formative or vital force, as we have noticed heretofore, and I think that any who have closely observed the phenomena of diseased action, especially in their own persons, will be satisfied of the concentration of this power to resist disease at any one point, and will so order the entire mechanism that its final removal will be effected.

455. Noticing the effects of this animal poison still further, we find that slowly the chill is removed, and following it there is great activity of the circulation, increased respiration and oxygenation, and an increased temperature. Undoubtedly the effect of the increased activity of function is to burn much material that would serve as a cause of disease, but all is not destroyed. Examining the entire progress of fevers, we conclude that the peculiar poison is rarely if ever burned, but that the increased combustion is confined to the waste of the body. In the case we are considering, the poison remains in the blood, and from it develops a material of like character from which the blood frees itself by throwing it upon the skin in the form of small-pox pustules. This may be regarded as an excretory act, and is always associated with elimination by way of the skin, kidneys, and bowels, in persons who recover

456. There are some things in the pathology of such a fever that we do not understand. We can not see the utility of the great excitation of the circulative and nervous systems, especially of its long continuance. Neither can we see why it is that the increased combustion, which is continuously maintained, does not consume the exciting cause—the animal poison.

457. It has long been remarked that, as a general rule, those fevers that were sudden in their advent, run but a short course, while those which had a long period of incubation had a protrac-

ted course. So true is this, that we may determine the duration of a fever, in a majority of cases, by this, and give it proper classification. No physician of experience would regard a fever as serious or of long duration that came up in one day or one night, in a person previously healthy, no matter how high the fever ran, or how much the patient suffered. But, on the contrary, if he learned that there had been a gradually increasing prostration, extending over a period of days or weeks, he would at once conclude that he had a protracted if not a serious case. Thus the duration of a fever is in almost direct ratio to the duration of the forming stage.

458. It seems to me there is but one explanation to this, and that is, that the organic poison causing the disease so influences the blood, during the stage of incubation, that the tissues formed during this period are imperfect. In other words, that all new formations after the introduction of the cause of disease are influenced by it, and that its natural duration is until all such material is removed. We frequently find persons who have recovered from a protracted fever saying that they feel better than they have for many months, like a new man or woman; and there is no doubt but that this is the case, as we know they are literally renewed.

459. The question, then, if these be facts, is: is it ever good policy to arrest the progress of a fever, but should we not rather watch its progress, see that there is no undue disturbance, and thus conduct it to its natural termination? If there is a certain amount of the solids that have an enfeebled vitality from the cause of disease, the person can never have perfect health until these are removed; and we observe in those cases of continued fever in which the emaciation has been greatest, that frequently this *renewal of life* is most complete; and conversely, that when there has been but little emaciation, convalescence is frequently retarded, and it is a long time before the patient feels entirely well. Now, while these are facts, I do not think it necessary to conclude that the fever must have a duration of from three to six weeks, and that the patient must be greatly emaciated and exhausted.

For, as we have seen, the processes of waste and excretion are deranged, and are not as rapid as in health, and experience proves that we may conduct these processes much better without than with the phenomena of fever, and finally arrive at the same result—the entire purification of the body. There is one additional reason why this should be done. Not only have we the formative lesion that has occurred in the nutrition of tissues during the period of incubation, but during the progress of the fever the other tissues are injured by direct contact with the animal poison, but principally by the derangement of function which is incidental to it.

460. I claim, therefore, that such treatment as will modify these derangements of function that we call fever, and will re-establish the normal waste of tissue, and its removal by way of the skin, kidneys, and bowels, and that will restore digestion, assimilation, and nutrition, to replace such waste, will form a rational treatment of fever. Let us notice the several parts of such a treatment. By the use of special sedatives we reduce the frequency of the pulse (rapidity of circulation) and the frequency of respiration—hence the supply of oxygen and combustion. We have remedies that control irritation of the nervous system, giving regular expenditure of nerve force, and increasing its amount if it becomes necessary. We have also remedies that to some extent control the septic processes in the blood, and antidote the fever poison. With the circulation reduced to the normal standard, we can readily obtain secretion and the removal of waste by the three principal emunctories: and we have other means that place the stomach in condition to receive food, that aid digestion and nutrition, and thus facilitate the replacement of the worn-out tissue as fast as it is removed. If it is tardy in breaking down, and in that retrograde metamorphosis which fits it for excretion, we have additional means which facilitate both of these.

461. It is not necessary to wait, therefore, for the slow processes of disease, which must necessarily be imperfect; but instead of this, we make provision for a more rapid waste of the diseased *material* of the blood and the diseased tissue, and at the same

time for its renewal by the organization of new tissue and new blood. As Dr. Chambers graphically describes it, it is a literal renewal of life.

INFLUENCE OF VEGETABLE MALARIA ON THE BLOOD.

462. A certain class of diseases are attributed to the action of a poison called *vegetable malaria,* but exactly what this cause is, is a matter of dispute. The facts, so far as we can gather them, are these : that in certain localities where the land is low and rich, and produces an abundant vegetation, when this vegetation undergoes decomposition in the fall, a certain class of diseases, *periodic* in their nature, arise. The intensity of the cause seems to be in direct proportion to the amount of vegetation and the rapidity of its decay. If the season is very dry, and the vegetable matters desiccate, there is little or no periodic disease; or if the season is very wet, so as to keep them thoroughly saturated, the process of decomposition is slow, and there is likewise immunity from this class of diseases.

463. These facts have led to the belief in *vegetable malaria* as a cause of the entire group of diseases manifesting distinct periodicity. And it is assumed that the exhalation from such decomposing matter possesses the property of setting up within the blood processes of decomposition which give rise to the phenomena of disease. In this light we have to view the gaseous exhalations as organic matter undergoing putrefactive decomposition, and capable, according to the propositions of Liebig, of setting up similar processes in other organized matter.

464. It is objected to this, that the most delicate chemical tests detect no difference in an atmosphere where ague prevails as an endemic, and in those districts where it is never known. To this it may be answered, that it is likewise impossible to detect, by any chemical process, any atmospheric change where cholera,

or fever, or any epidemic disease, is prevailing, though there is no doubt whatever but there is a very marked change.

465. To the facts named in (462) we may add that the poison is cognizable by the senses, so that a person very susceptible detects a difference as soon as he is brought into an atmosphere impregnated with it; that it will set up a putrefactive process in animal or vegetable matter, according to the laws laid down by Liebig. Thus numerous experiments have proven that fresh meat decomposes much more rapidly in the atmosphere of a swamp than it would in the pure air of high grounds. Another experiment is suggestive, though very crude: the atmospheric moisture condensed by ice speedily undergoes putrefactive decomposition, and presents the most tangible evidence of noxious matter to our senses. If distilled water, fresh animal flesh, or vegetable matter, be placed under a bell-glass and the air exhausted, no animal or vegetable growths will be found after the lapse of days or weeks; but admit the air, and a multitude of microscopic forms will be developed in a few hours. If the air we breathe is thus loaded with the larvæ of animal life, and the seeds and sporules of vegetable life, which can not be detected by any process known to science, we have no reason to reject the doctrine of malaria because it has not been thus detected.

466. The influence of the paludal poison, whatever it may be, is very similar to that heretofore noticed. It manifests itself first in a growing debility so insidious that the person hardly realizes his loss of strength and vigor until the disease is fully ushered in. All the processes of life seem to be enfeebled, and there can be no doubt that the nutritive processes are enfeebled, and the tissues are really imperfect. We have the positive evidence of this in the severer and more protracted cases of the disease, in the appearance of the surface and the sensation given in passing the hand over the surface. This gradually increasing loss of vitality at length culminates in a chill, following which is febrile re-action, and then a secreting stage. This is the typical form of the disease, but there are many variations from it.

467. In an intermittent fever we have the paroxysm as above-named, in which the system seems to free itself from the poison, and then comes a period of rest, or rather restored function and health. But in a longer or shorter time the cause reproduces itself, and we have another paroxysm as before. I have no explanation to offer for this *periodicity* of disease, as every one of my readers can form his own theory from the facts presented, and with as much probability of being right. What we observe is, that many functions of the body are performed periodically, and this morbid process is influenced by similar laws.

468. It has been proven that this cause of disease may be avoided, at least to a very considerable extent. If the dwelling is placed in the forest, and the ground remains unbroken, there is but little of this influence. So if a house built on the prairie is sheltered in the course of prevailing winds by a grove of trees, or by an elevation of ground, and the land is left unbroken for some distance around it, there is almost entire immunity. On the contrary, the miasmatic poison is developed by cultivation and clearing, and a house placed in either newly cultivated ground or a clearing, insures ague to the inhabitants. There are medicinal antidotes to the malarial poison, but I need mention but one —*quinia*—which is so positive in its influence, that it is relied upon by vessels visiting the intensely malarial regions of the African coast.

469. Dr. J. H. Salisbury reports a series of observations made upon this subject—*American Journal of the Medical Sciences*, Jan., 1866—and claims to have uniformly detected in the atmospere of malarious regions multitudes of *algoid* cells, from plants of a *palmelloid* type. Suspending plates of glass one foot above the ground during the night, the under surface would be covered with drops of water, which, when examined with the microscope, showed this vegetation. The most singular part was, that the sputa of soldiers sleeping on the ground in such localities showed these cells in large numbers. From these observations Dr. Salisbury claims that this cryptogamic vegetation is the cause of periodic disease.

470. If now we examine the evidence that the lesion in these cases is primarily and principally of the blood, we will find it abundant and conclusive. In his remarks upon the intermittent fevers of the Genessee country, Dr. Stephens says: "During my residence in this country, in the months of September and October, 1830, I bled several individuals who resided in some of the most sickly places, but who had not yet been attacked with the fever. In every one of these the blood invariably presented the same peculiar diseased appearance which I had observed in those who reside near the swampy situations in the West Indies. It was very dark in color, and evidently deranged in its physical properties, while the serum which separated, in place of being clear, had a muddy or brown color, and in some cases an oily appearance. In fact I did not meet with one intelligent practitioner in that country who did not recognize the fact that the blood of the inhabitants, during the sickly months, was very different from that of those individuals who arrived from healthy situations; while even in those who reside in the most unhealthy situations, and who had not yet had the fever, it is not only dark in color, but evidently so much diseased in its properties as to be very unlike the blood of health."

471. Passing over the opinions of Drs. Tweedie, Rush, Hume, and many others, we will adduce some recent investigations on the same subject by Dr. J. Forsyth Meigs. The first case was a young unmarried woman, who had suffered with intermittent fever for six weeks. "On pricking the finger and placing a drop of blood under a quarter-inch lens, it was seen that the red corpuscles were not more than one-fourth as numerous as in health; the white corpuscles were about normal in quantity, but what especially arrested attention was the presence in the field of numerous particles of irregular shape, with angular edges, of blackish color and entirely opaque. These were the pigment granules of Dr. Frerichs." In case third, "the blood drawn from the finger exhibited under the microscope more than the normal proportion of white corpuscles, with several pigment *granules* in each field. The red corpuscles appeared gelatinous,

and not only gave up their coloring matters to the added water, but, for the most part, entirely dissolved or left only a filmy residue."

472. These are the grave appearances of diseased action, and I have only brought them forward to prove that even to our senses the evidence of diseased blood is conclusive. But as I have had occasion to remark before, we can not, by the microscope or chemical re-agents, detect those subtle changes which influence the formative force in construction, or the chemical forces in disintegration, even though we may appreciate their existence, and by extended observations and comparisons, determine their laws.

473. *Treatment.*—Recognizing a malarial poison in the blood as the cause of diseased action, it would be rational to employ an antidote to this if such can be found. Quinia is the only agent that has a marked influence in this direction, and though we can not tell why or how, the fact is evident that it possesses the antidotal power. We have noticed the fact that it is employed to resist the poison, or as a prophylactic. To get this antidotal influence, it is necessary that the stomach be in such condition that the necessary quantity may be speedily absorbed, that it does not irritate the nervous system, and that the excretory organs are in such condition that they may be readily influenced to increased secretion. The only other agent that has been employed as an antidote to the malarial poison is arsenic, but it is very doubtful if it has any such power. The other means employed are such as will restore a normal activity of the digestive organs, improving the appetite and digestion, and consequently nutrition. And by the use of diaphoretics, diuretics, and mild cathartics, we stimulate the removal of all imperfect material from the blood. There is no doubt but that a treatment that has for its object activity of the excretory organs, and consequent rapid removal of waste, and many times increased waste, and an improved digestion and nutrition, is not only an important part, even when quinine is employed, but will effect a radical cure without the use of an antidote.

474. As evidence of the correctness of the position assumed, I quote from Dr. Golding Bird: "Although believing most completely that ague is primarily excited by the influence of a peculiar septic poison derived from marsh malaria, I do not for a moment assert that this particular poison is excreted in the urine during the recovery of the patient. The great influence of the malarious poison is, in all probability, essentially and primarily exerted upon the nervous system, especially on the organic or ganglionic structures, which preside so importantly over the functions of secretion. Thus all the secretions elaborated in the body become effected, and, as is well known, a remarkable tendency to congestion is observed in the portal circulation, destined more particularly for the depuration of matters rich in carbon. (?) There can be no doubt that the unhealthy secretions thus formed become active agents in keeping up in the body the impression of this disease. One of the great elements of successful treatment must, of necessity, be the depuration of the blood, and thus by freeing the system from the depressing influence of these vitiated matters, allow the vital powers to throw off the influence of the poison which for a time oppressed them."

INFLUENCE OF ANIMAL MALARIA ON THE BLOOD.

475. We have already examined the laws by which decomposing animal matter acts upon other matter containing its elements, and in this place we wish only to look at it as a cause of disease when introduced from without the body. Quite a number of diseases are supposed to owe their origin to this cause, the principal of which are the *continued* fevers, *eruptive* fevers, and erysipeloid inflammations. These may be either *endemic, sporadic,* or *epidemic,* and vary in intensity according to the activity of the animal poison.

476. These affections are endemic when confined to single sections of country, and in almost all cases it is easy to determine

the source of the miasm. When it is sporadic the cause is exceptional, and is sometimes difficult of detection. When the influence becomes epidemic, the cause is transmitted and propagated in the atmosphere, receiving new accessions from every case of the disease. Certain classes of these diseases are *infectious*, producing the poison in such form that it will influence others who come in contact with it. The eruptive fevers are naturally infectious, reproducing the animal poison that propagates the disease. Others are only infectious under certain circumstances, as typhoid, typhus, and puerperal fevers, and erysipelas, the cause of the disease assuming greater intensity in proportion as the disease is aggravated.

In reference to this Dr. Williams remarks: "The blood is probably the chief seat of the morbid poisons which excite various contagious epidemic and endemic diseases; and when these act most intensely it is much changed in its physical characters, being rendered darker, indisposed from defect of fibrin to coagulate, with breaking up of many red corpuscles. Probably, too, the blood is the hot-bed in which the morbid poisons are propagated, whether by seeds, ova, cell-germs, or parasites; and it is through changes in its composition that many of the destructive effects of these poisons are produced.

"Dr. Francis Howe communicated measles from one person to another by inoculating with the blood of a patient affected with the disease. Gendrin describes the following experiment: 'A man who had been skinning a diseased animal was seized with putrid fever, attended with an eruption of sloughing pustules. Some blood taken from this man was injected into the cellular tissue of the groin of a cat; the animal was soon affected with vomiting of bile, dyspnœa, frequent, small, irregular pulse, dry, brown tongue, with slight convulsions, and died seven hours after the injection.' The same pathologist produced in animals various severe symptoms, speedily ending in death, by injecting into their veins blood from a person laboring under confluent small-pox. MM. Dupuy and Leuret communicated to a healthy horse the malignant *pustular disease* called *charbon*, by injecting into its

veins some of the blood of a diseased animal; and M. Renault propagated glanders from one horse to another in the same manner. Andral quotes from Duhamel an extraordinary case, in which, blistering, pustules, malignant fever, and death, followed the mere contact of the diseased blood of an animal with the lips. Other instances are on record of sickness, faintness, and serious illness being caused by the odor of blood."

477. I do not think it necessary to adduce other evidence in proof of the existence of such animal poison, or its influence upon man, for it is generally received as true. And if the reader will again turn back to the quotation from Liebig, he will have the laws that govern the formation, action, and propagation of these animal miasms.

478. The contagion of cholera undoubtedly belongs to this class. Generated where human beings are closely crowded together without regard to cleanliness, drainage, or ventilation, and with the degree of heat and moisture that favors a rapid putrefactive process, it resembles typhus or yellow fever. So, likewise, it receives a fresh accession of strength wherever it finds the same conditions, as was markedly manifest in the rapid spread of the last epidemic. Not only does it bear this relationship to other animal poisons, but we must regard it not only as an epidemic, but also as a contagious miasm. The proof that the poison of cholera produced during an attack is the exciting cause of other cases is beyond cavil. But although we must regard the epidemic influence in the atmosphere, yet the disease is only propagated through persons, or material that has come in contact or received the excretions of cholera patients.

479. The means of *prophylaxis* against this class of diseases may be arranged as follows: First, as regards the entire removal of the source of infection, as when a cesspool, drain, cellar, etc., is thoroughly cleansed, and all animal matters are removed; second, when by the use of a class of agents termed disinfectants the products of decomposition are destroyed, or the process of decomposition is arrested; and third, by careful attention to the general health, and especially that excretion is free, and all the

processes of life well performed, we enable the body to resist the action of the poison, and cast it out when it has gained entrance. The first is of most importance, and should always secure attention if possible. I have known instances, where a neighborhood was severely scourged with typhoid fever, losing some of its members, when a few days labor would have entirely removed the cause. Our experience with cholera not only proved the value of cleanliness, but also the benefit to be derived from a judicious use of disinfectants. In New York the cholera poison was literally fought out of the city by the use of this class of agents.

480. It may be stated that none of these poisons are capable of producing disease unless there is a failure of vital power in the individual to be attacked.* No person in the possession of a sound, active body, will be attacked, no matter how virulent the

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*"It has been already stated that the disposition to suffer from zymotic diseases is connected with a weakness of the functions generally, but it is more particularly favored by the presence in the blood of an easily decomposed azotized matter resulting from the retrograde transformation or decay of tissues. Thus after great bodily fatigue, after severe wounds or other injuries, and after delivery of women, where there is more than usual of an effete matter in the blood, there is great susceptibility to zymotic diseases and a liability to them in an aggravated form. So also in the development and progress of these diseases, we have many proofs that their essential seat is in the blood, though their action may be exerted on various tissues or organs. Thus the earliest symptoms are those of general weakness and uneasiness, with disturbance of the circulation more constantly than of any other function; and not unfrequently, as before mentioned, with an obviously altered condition of the blood. In the worst cases of zymotic disease, where the poison is most virulent, the change approaches to putrescence; and the excretions first, and eventually the whole body, exhale offensive odors, and give evidence of the prevalence of a decomposing force opposed to the conservative powers of life: and this corrupting influence may triumph in a few days, or even in a few hours, before any secondary or local changes can take place. This has been observed to happen in the plague and in the worst forms of putrid or pestilential fevers, in which the blood seems to be so rapidly corrupted that it no longer sustains the functions of life. In like manner the poison of the most venomous serpents appears to exert its deadly influence on the blood, which it renders the medium of death to the whole body.

"But the more usual operation of zymotic poisons is of a more mixed character, comprising much local irritation as well as constitutional disturbance *and depression.* Thus the poisons of the exanthemata produce

cause. It requires a previous debility, either from physical exercise, from irregular meals, from change of diet, from excessive emotions, or the many slight causes of disturbance to which men are constantly exposed. It will be noticed that in each of these

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various specific forms of cutaneous inflammation; and that of scarlatina also affects the throat and frequently the uriniferous tubes, and measles the air passages—with inflammatory or congestive disorders.

"The follicular intestinal lesions in typhoid fever, and the more intense phlogoses and ulcerations of epidemic dysentery, are further examples of local irritation resulting from the presence of a morbid poison in the blood. Now, although these local inflanmmations are proofs of the activity of the respective poisons, and are, in fact, the foci of their multiplication, yet they appear to be parts of a process by which the poison is brought to a surface from which it may be eliminated from the system, and the blood freed from its contaminating influence; for they all involve more or less of a process of effusion and discharge, and the more simply and superficially this takes place, without spreading deeply and disorganizing the textures, the more favorable will be the result. Thus scarlatina, the eruption of which is vivid and soon ending in desquamation, the throat-inflammation superficial and attended with free secretion; measles with full florid eruption, and the catarrhal affection ending early in defluxion and expectoration; small-pox with distinct pustules circumscribed by a firm phlegmonous base, which protects the system while the pustule maturates, and then soon dries into a hard inert scab; typhoid fever, in which an early moderate diarrhœa indicates the activity of the intestinal follicles in throwing off the morbid matter: these are examples of the favorable operation of the *vis medicatrix naturæ* in the removal of a noxious influence. On the other hand, in scarlatina, where the eruption is not persistent, or is livid, and the throat inflammation is deep-seated, with much swelling, sanious and fœtid discharges, and sloughy patches; in measles, with a dusky and imperfect rash, and the inflammation of the air-passages assuming the form of croup, extensive bronchitis, or even of pneumonia; in small-pox, a very copious eruption of confluent, flattened pustules, with little or no induration at their base, but much dark-red diffuse swelling of the integuments and cellular tissue, sometimes with purple ecchymosed spots or petechiæ, and sanguinolent discharges from various mucous membranes; in typhoid fever, a torpor of the bowels and other excreting organs, with tympanitis, dark sordes on the teeth and tongue, petechiæ on the skin, and general oppression of all the functions: in such forms of disease we see evidence of a prevalence of the operation of the poison in depressing the vital powers, in injuring the condition of the blood, and in depressing the local processes intended for the protection of the system. Various combinations and complications of these two opposing influences—the poison and the re-action against it—constitute the infinite diversity in type and form that toxæmic diseases present."—*Williams'* "*Principles of Medicine*," pp. 199, 191.

there is not only a temporary exhaustion of vital power to resist disease, but that they tend to increase the amount of effete material in the blood, which is a *nidus* for the animal malaria. The third means of prophylaxis, therefore, should never be neglected. Thus we insist that those who nurse the sick shall be healthy, shall have their food with regularity, shall not be exhausted by over-exertion, and shall have regular periods of rest, and all persons within reach of the infection should be protected by well-regulated habits, and by appropriate medicines, if there was a failure in any important function.

481. *Treatment.* In looking at the diseases produced by this cause, we can not but remark that in most cases the rapidity with which the poison acts upon the blood is almost in direct proportion to the excitation or irregularity of function. With a rapid circulation and respiration, and an excited innervation, a fever progresses rapidly to the destruction of blood and tissue, and consequently to life. With an irregular circulation, respiration, and innervation, the destructive process progresses just as rapidly. Therefore, I claim that the first indication in all of these cases is to obtain a *regular* circulation, respiration, and innervation.

482. If the pulse is frequent, and the blood courses through the body with great rapidity, the special sedatives should be employed to reduce the circulation to a normal standard. But if the current of blood is sluggish or feeble, especially as regards the capillary circulation, with tendency to stasis in internal organs, and proportionately feeble circulation to the surface and extremities, means should be employed to get a more vigorous action of the heart and arteries, and an equal distribution of blood. In addition to counter-irritation and dry heat, I would suggest small doses of belladonna as answering an excellent purpose in this case. These are the most important parts of a rational treatment, and must precede all other means.

483. An excited innervation exhausts vitality, and is one of the most prominent causes of death in many of these cases. It is much worse than feeble innervation, for it causes an expenditure of that which is absolutely indispensable to life, while the

last is sometimes conservative. The means for controlling these lesions of innervation will be named hereafter.

484. If we can control the circulation and innervation, we not only check the action of the poison, but we place the excretory organs in such condition that they can perform their function, and thus remove the effete matters and animal miasm. This is the case in cholera as well as in fever, though in the one case the condition of the circulation is directly opposite to what it is in the other. It is not possible to remove the whole morbid product in one day; indeed it may require several days; but if it is possible to get secretion at all, proper means will continue it. I have stated before, it is the gentle action of the excretory organs that we want, rather than great activity.

485. In the mean time there are certain remedies that control the putrefactive process, and to the extent that they do this without impairing the vitality of tissue, they will be found useful. Of these I may name the *alkaline sulphites, chlorate of potash,* the *mineral acids, baptisia tinctoria, yeast,* etc. The directions given in (424) will enable the reader to select the agent best adapted to the case.

486. There are some agents which tend to conserve and increase vitality, as the bitter tonics and stimulants, and these may be occasionally employed with great advantage. But the stomach being kept in good condition, an essential part of the treatment is, that the patient be supplied with a portion of easily-digested food in fluid form. This is an indispensable part of our treatment, and one to which we attribute much of our success.

CHAPTER VI.

THE LYMPH AND ITS CIRCULATION.

487. The lymphatic circulation has not been studied as much as some other less important parts, though much of its history is quite well known. From every portion of the body the small lymphatic vessels carry a material which, after passing through the lymphatic glands, is discharged into the general current of the blood. We know but little of the motive-power by which the lymph is moved through the vessels, but judging from their resemblance to blood-vessels, we attribute it to the contraction of a muscular coat. Their origin in the tissues is also obscure, but they seem in general to form a plexus in the substance of the tissues from which the convergent trunks arise.

488. *Lymphatic glands* are interposed between the tissues and the thoracic duct, which discharges the lymph into the subclavian vein, so that every portion of this fluid must pass through these glands before it can reach the general circulation. The structure of these glands has not yet been fully determined. Some years since all writers were agreed that the lymphatic vessels entering the gland were divided up as it were into capillaries, and that these again converging and uniting formed the large vessels leading from it, there being a direct communication and circulation of lymph through them. But it has lately been proven that there is no continuity of vessels, but that the *afferent* lymphatics divide and are lost in a peculiar cellular structure, from which the *efferent* vessels arise. This cellular structure receives a very abundant supply of blood through capillaries which are very minute.

489. When we study the lymph itself we find authors differing in their views. The majority of writers regard it as a material that has been gathered up from the nutrition of tissue ; in other words, they suppose a surplus of material thrown out, like chips about a building, and it is the business of the lymphatic system to save this waste material, and carry it back to the circulation. I do not think there is the slightest foundation for such a theory, as we observe nothing analogous to it in any other function. In nature's processes the *means* are exactly adapted to the *ends*, and as long as health is maintained there is no surplusage.

490. We have heretofore seen that both red corpuscles and white corpuscles had their origin outside the circulation, and we traced it to the lymphatic system. Now I think we have the best of reasons to believe that the lymph is not a waste, but rather that the formative force, which is active in the tissues, elaborates it as a basis for the formation of new blood. Going still further, we may reasonably suppose that it is the representative of tissue in its innate character, and thus every tissue and part would be represented in the new formation of blood. If we examine a lymphatic gland we will find that it is a depot for the rapid multiplication of cells, and this lymph is doubtless the material of which they are principally formed. And in the healthy condition of the body, the current of lymph passing from the glands to the blood, contains an immense number of these new formations

491. The lymph, then, is the basis of the blood, and represents each individual part, and the vitality of the whole. It furnishes the germs of the red discs and white globules, and the principle of organization for the entire mass of the blood. Studying the lymphatic system in this way, it assumes an importance it never possessed before, and I believe that its pathology and therapeutics will be studied with more care. The evidence of the truth of these propositions I think very conclusive. First, the lymph bears no resemblance in its physical properties to material of low organization, but, on the contrary, seems to be very pure and plastic. Second, the lymphatic glands present a very active cell-

growth, in that intermediate structure from which the lymph is regathered. And third, the lymph passing from the glands to the blood is a highly organized fluid, and contains the germs of the future corpuscles of the blood.

492. If we examine the history and nature of certain diseases which markedly affect this system of vessels, we will see that the above propositions gain additional support. Let us take first the malignant growths; it is now generally admitted that they are at first local, but that afterward the entire system is influenced in a peculiar manner, and frequently without the development of similar growths. It is conclusively proven that the so-called cancer-cells can not get into the blood through the veins, and if they should be taken up by the lymphatics (which is just as impossible, as they do not commence by open extremities), they could not pass the first glands. So that Virchow, to give any reasonable explanation, had to suppose a cancer fluid or juice, which was capable of absorption. Now it is clear to me that this heterologous formation, developed in the normal connective tissues, and using its blood-vessels, lymphatics, and nerves, should obey, to some extent, the laws that govern normal nutrition. We know that it does furnish the lymphatics with lymph, which at first passes the lymphatic glands freely, and always passes to some extent, *and this material is the basis from which a portion of the blood is to be developed;* that is, it represents this growth in the blood in the same manner as the lymph from sound tissues represents those tissues. As the growth increases in size and strength its influence on the blood becomes more marked, until at last it gives us that peculiar condition termed the *cancerous cachexia.*

493. Syphilis is another very marked example of the truth of these propositions. The poison always gains entrance through the lymphatics, and some of the earlier and more constant phenomena are of this system of vessels and glands. I claim that the reason why the disease is so general, so obstinate, and causes such varied and sometimes fearful lesions of nutrition is, because it is a disease of the lymphatic system, and poisons the fountain from which the blood is drawn. I have made a number of ex-

aminations upon the cadaver in persons who were suffering from constitutional syphilis, and in every case I found perceptible lesions of the lymphatic glands. In one severe case, in which there was ulceration, nodes, and syphilitic psoriasis, there was not a sound lymphatic gland in the body. This person had died of the syphilitic cachexia. So confident am I of the correctness of these statements, that I will risk my reputation that no case of secondary or constitutional syphilis can be found in which disease of the lymphatic system is not present.

494. If we examine the matter closely, we will see that there is no other way in which we can rationally account for the continuance of the disease as a permanent part of the life of the individual. The ordinary supposition that it is a morbid material in the blood, and goverened by the same laws that control other animal miasms, is untenable; for it would be an exception to the rule that after a longer or shorter time they are *always* removed by the excretory organs. On the contrary, we find that remedies that simply increase secretion do not influence this virus, but, on the contrary, it requires remedies that influence the lymphatic system So true is it that the lymphatic system is the seat of the disease that many physicians at once examine certain parts of the body, to determine the condition of the glands, whenever a new case presents. A friend of mine claims that in a very extensive experience, extending over many years, he has never seen a case in which there was not enlargement of the *occipital lymphatic* glands.

495. If we examine the history of *scrofula*, we will find additional evidence of the truth of our proposition. It is a lesion of the lymphatic system, and necessarily the formation of blood is influenced by it, but it is only when, from some exciting cause, this lesion is greatly increased, that we have such marked impairment of the blood. I do not refer to the scrofulous inflammation of the glands, for in this the deposit in and around the gland is evidently from the blood and is not accumulation of lymph, as is supposed by some. It is the *initial* lesion that interests us—that

which influences the formation of the entire mass of the blood and the nutrition of every tissue.

496. To show the present *want* of knowledge on this subject, and as a *negative* proof of the truth of my proposition, I will make two quotations, the first from Dr. John Hughes Bennett, when describing the pathology of exudation; the second from Mr. Paget, when speaking of the scrofulous or strumous diseases.

Dr. Bennett remarks: "Of the ultimate cause producing this difference in the formative power of the exudation we are ignorant but reasoning leads us to the conclusion that these changes and effects depend, not upon the vascular system, which is the mere apparatus for the production of exudation, nor upon the nervous system, which conducts impressions to or from this apparatus, and not on the texture which is the seat of the exudation, as that varies while the cancerous or tuberculous formation is the same, but upon the inherent composition or constitution of the exudation itself. On this point most pathologists are agreed, and hence the supposed existence of various kinds of dyscrasiæ which orignate in the blood, and, as it is imagined, explain the different results produced. And here pathologists pause; having traced the disease back to the blood they are content; but they have not sufficiently taken into consideration that the blood itself is dependent for its constitution on the results of the primary digestion in the alimentary canal on the one hand, and the secondary digestion in the tissues on the other; yet it must be evident to every physiologist that if it be the constitution of the blood which determines the constitution of the exudation, the causes which produce the latter must be sought in those circumstances which operate on the composition of the former fluid."

497. Mr. Paget, describing the *scrofulous* or *strumous* condition, says: "It is, I fear, impossible to clear the confusion arising from the interchanging use of these terms, or to define exactly the cases to which they should severally be applied; but where the definition of terms is impossible, the next best thing is an understanding of their meaning according to general usage. 'Scrofula,' or 'struma,' then, is generally understood as a state of constitu-

tion distinguished in some measure by peculiarities of appearance even during health, but much more by peculiar liability to certain diseases, including pulmonary phthisis. The chief of these 'scrofulous' diseases are various swellings of lymphatic glands, arising from causes which would be inadequate to produce them in ordinary healthy persons. The swellings are due, sometimes, to mere enlargement, as from an increase of natural structure; sometimes to chronic inflammation; sometimes to more acute inflammation, or abscess; sometimes to tuberculous disease of the glands. But, besides these, it is usual to reckon as 'scrofulous' affections certain chronic inflammations of joints; slowly progressive 'carious' ulcerations of bones; chronic and frequent ulcers of the cornea; ophthalmia attended with extreme intolerance of light, but with little if any of the ordinary consequences of inflammation; frequent chronic abscesses; pustular cutaneous eruptions, frequently appearing upon slight affections of the health or local irritation; habitual swelling and catarrh of the mucous membrane of the nose; habitual swellings of the upper lip."

498. "Now these, and many more like diseases, are among us, both in medical and general language, called scrofulous, or strumous; but, though many of them are often coincident, *yet it is very difficult to say what all have in common,* so as to justify their common appellation. Surely they are not all tuberculous diseases. Little more can be said of them than that as contrasted with other diseases of the same form and parts, the scrofulous diseases are usually distinguished by *mildness* and *tenacity* of symptoms; they arise from apparently trivial local causes, and produce, in proportion to their duration, slight effects; they are frequent but not active. The general state on which they depend may be produced by defective food, with ill-ventilation, dampness, darkness, and other depressing influences; and this general state of the constitution, whether natural or artificially generated, is fairly expressed by such terms as 'delicacy of constitution,' 'general debility,' 'defective vital power,' 'irritability without strength.' Such terms, however, do not explain the state that they express, for *they* all assume that there are, in human bodies, different degrees

of vital power, independent of differences of material, which is at least not proved."

499. Now, if the reader will carefully examine the history of the affections named by Mr. Paget, and all those that come under the term dyscrasiæ, or, in common language, *bad blood,* he will not only see that they have *something in common,* but that they are clearly dependent upon a lesion of the lymphatic system. I do not think it necessary to give additional proof, preferring that the examination be made by the reader, for frequently a multiplicity of argument but obscures the important points of the subject.

500. Conceding the correctness of the proposition, we find a new therapeutic study. For it is not those marked effects that we know by the name of emesis, catharsis, diaphoresis, etc., that reach these subtle processes of nature, but that more gentle action which influences and controls vital processes. Our present system of therapeutics may be compared to the *scoring* and *hewing* in the forest; it is rough and uncouth; in the future it will be like the operations of the watchsmith, smooth and even, and having reference to the operations of the machine. While I would discard the rough action of the old system of medicine, I do not propose to go to the other extreme, and adopt *infinitessimals,* for there is a happy mean which gives the desired action of remedies. I do not propose to designate a treatment for these lesions, or name single remedies that act upon this system of vessels, for the subject is not sufficiently studied; but I desire to point the way for such investigations, which I think will add much to the certainty of practice.

501. The *lacteals* are not included in this description, as their office is very different, and there is but little resemblance between the chyle which is carried forward by the one and the lymph of the other. Disease of this part of the lymphatic system would be associated with derangements of digestion, as we see in *tabes mesenterica.*

CHAPTER VII.

LESIONS OF THE CIRCULATION OF THE BLOOD.

502. As we have heretofore seen, a regular and uniform circulation of the blood is indispensable to the correct performance of every function of the body; consequently derangements of the circulation will prove a cause of disease, and will form a part of a large number of affections. The lesions of the circulation, therefore, become a very important study, both as regards the cause and the cure. In all inflammations the lesion of circulation seems to be the basis of diseased action, and in fevers it also seems to hold the most important place.

503. To get a correct appreciation of the derangements of the circulation, it is necessary to study its several parts, and appreciate their relative value to the whole, and their influence on other functions. The heart is a powerful hollow muscle, and undoubtedly furnishes the largest amount of power for the circulation. The arteries have a distinct muscular coat, which, contracting on the wave of blood, adds additional force. Beyond this we know but little, as we can not determine any structure in the capillaries that would aid the movement of the blood, and we can not for a moment entertain the idea of *attraction*, which has been urged as an explanation of capillary circulation. The venous circulation is undoubtedly dependent upon the action of the heart (suction), upon muscular contraction in the course of the veins, and possibly to some extent upon the inspiratory movement of the chest.

504. It is principally under the influence of the *vegetative* (sympathetic) system of nerves, and is subject to all the laws governing muscular motion. Thus it will be perfect if there is

normal nutrition of its own muscular tissues, and good innervation. It will be imperfect when its nutrition is impaired, and present great changes of function from deranged innervation.

505. The heart, arteries, and veins, which we can see and appreciate, are usually thought of when the circulation is spoken of, but the most important processes of life are in that system of vessels beyond this, and which we can only perceive by the microscope. The capillaries are the vessels which come into relation with the tissues, and the various functions of nutrition, secretion and innervation. These vessels, though all microscopic, vary very greatly in size, from the twenty-five hundredth part of an inch to the fifteen thousandth of an inch in diameter. The smaller ones carry the *liquor sanguinis* only, and are only visible when distended. That they are very numerous is proven during the progress of an inflammation, when large numbers of them become so dilated as to receive red discs.

506. So abundant is this distribution of capillaries, that the intercapillary spaces exceed the diameter of the vessels but very little, so that, taking any given tissue, we can say that its substance is to a very considerable extent capillary blood-vessels. I have been accustomed to give my classes an idea of the minuteness of this circulation and its magnitude as a whole, in this way: "It is very certain that the intercapillary spaces are so small as never to be perceptible to the naked eye; if, therefore, a man was divested of all other tissues, leaving the capillaries intact, we should not be able to detect by sight that there was anything gone. If the capillaries make one-third or one-fourth part of the soft structures, it gives a very minute distribution of blood. And if this can be appreciated, derangement of the capillary circulation will be seen to have great significance as a part of diseased action."

507. The classification of Dr. Williams is very convenient, but I have found it impossible to be governed by it heretofore, but on this subject we will use it as a basis to direct our studies. Referring to the introduction, the whole classification may be seen, but we have only use here for one part.

The Circulating Blood.

- Deficient in quantity—anæmia.
  - General.
  - Partial.
- Excessive in quantity—hyperæmia.
  - General—plethora.
    - With circulation
      - Increased—sthenic.
      - Diminished—asthenic.
  - Partial—local hyperæmia.
    - With circulation
      - Increased—determination of blood.
      - Diminished—congestion.
      - Partly inc. / Partly dim. — Inflammation.
- Perverted in quality—Cacæmia.

508. We have already considered the defect, excess, and perversion of the blood, and will, therefore, confine our attention entirely to the lesions of circulation. I do not recognize an excess of blood as a cause of disease, nor as a part of disease, but rather as an addition to life or the power of living. And it is only when the blood itself becomes impaired, or its circulation deranged, that we recognize such excess in diseased action. We may restrict the term hyperæmia, however, to the blood in circulation, and may, therefore, recognize a general as well as a local hyperæmia.

GENERAL HYPERÆMIA.

509. Using this term strictly with reference to the circulation, and not to the total amount of blood, we recognize two conditions, which may be named *active* and *passive*. An *active general hyperæmia* is that condition in which the blood is circulated freely and rapidly, so that each individual part receives a larger amount of blood in a given time than it does in health; while a *passive general hyperæmia* is that condition in which there is a sluggish capillary circulation, and in consequence of this there is in these vessels a larger amount of blood than in health.

510. *Active General Hyperæmia.*—That vascular excitement which forms so prominent a part of fever is the best example of

active general hyperæmia. In this case the heart beats frequently, the arteries give their aid, and the result is a free and rapid circulation of the entire mass of the blood. Of course there is great variation in this; in some cases, when the heart contracts forcibly, there is a greater amount of blood poured through the capillaries with a pulse of 100 beats per minute, than in other cases where it is 140.

511. We recognize two conditions leading to this active circulation. The first is undue excitation, leading to an expenditure of real force, but it is always of slight duration. It is the condition we observe in anger, or any sudden excitement, and gives a proportionately increased power for the time being. We see it in many cases of evanescent fever (*febricula*), and occasionally in the symptomatic fever attending cold or an injury. Usually it gives the increased circulation in the first stage of a sthenic fever or inflammation.

512. In the second case the rapid circulation is but the evidence of debility. The heart contracts more frequently because it has lost power, and just in the ratio of this loss. In many of these cases the active hyperæmia is apparent, not real; even though the heart beats forcibly and frequently, a smaller quantity of blood is circulating through the capillaries. The recognition of this point I consider of special importance in the pathology of fever, for upon this is based the restorative plan of treatment.

513. It is not necessary to inquire in this place why the heart is thus influenced; we know the fact that the febrile poison, when introduced into the blood, first depresses all the powers of life, and that this depression is antagonized by that reaction which is known as fever, of which the excited circulation is a prominent part. Increased respiration, oxygenation, and combustion attend it, and will finally, as we believe, remove the poison from the blood. Still we think there is a better means of attaining the same end.

514. With an active circulation there is usually excitation of the nervous system, and undue expenditure of nerve force, and one *reacts upon the other* to increase the lesion of each. There

in the arrest, to a greater or less extent, of the processes of digestion, nutrition, and secretion, and these seem to be dependent to a very great extent upon the derangement of the circulation, for they can not be re-established while this exists, and they are restored when it is corrected. We may say, then, that the lesion of circulation forms the basis of fever, that all other morbid phenomena are to a considerable extent dependent upon it, and that a correct treatment looks to the correction of this at first, without which nothing else can be done. To state the matter in a different form: If it is necessary to restore secretion from the skin, kidneys, and bowels, and place the stomach in condition to take food, it is first required that this abnormal excitement of the vascular system be controlled.

505. *Treatment.*—Where there is a temporary excitation, with real increase of power, we find that cold affusion, a saline cathartic and diuretic, with a spare diet, answers an excellent purpose. Or in the case of sthenic fever or inflammation, a nauseant may be given, and continued to complete relaxation and sedation. Or in the same case the special sedatives, veratrum and gelseminum, may be given so as to produce their toxic effects—complete relaxation and consequent sedation.

506. In the second and far more numerous class of cases, the *excited action of the heart and rapid circulation is an evidence of debility*, and I *object* decidedly to any means which will still *further impair* vitality. On the contrary, I use remedies which *give increased* power to the heart to circulate the blood, and *remove obstructions* to its free circulation. I have taught for many years that the medicinal action of the *special sedatives*, aconite, *veratrum viride*, and digitalis, was to increase the power of the heart *to circulate* the blood, and just in proportion as it gained power there would be a reduction in the frequency of the pulse. I have tested this matter so thoroughly, that I think there can not be a doubt of its correctness. Within the past few years it is generally admitted that digitalis is a tonic to the heart, and

some claim that it is the most certain as well as the most powerful agent that can be employed.

517. Observe the influence of *small* doses of aconite and veratrum on the circulation during a fever. There is no sudden bringing down of the pulse as when veratrum is given in large doses, as indeed we could not expect, for tone and strength are not speedily imparted. But, on the contrary, we observe a very gradual influence to the amount of five beats in each twenty-four hours, and with a proportionate diminution of temperature as shown by the thermometer, and relief from many unpleasant symptoms attending the rapid circulation. The pulse is never reduced to seventy, sixty, fifty, or forty beats per minute, as we are so often told by those who recommend veratrum in large doses. But this gradual decline continues until it is but five or ten beats above the normal standard, where it remains stationary until the fever is overcome.

518. It will be further observed that as the pulse declines in frequency it gains in strength, and there is really a more vigorous as well as a more equal circulation of blood. I claim that the sedatives *increase* the power of the heart at the same time that they remove obstruction to the free circulation of the blood. This is in direct opposition to the common opinion that they prove sedative by *depressing* the power of the heart. There is no doubt we have to some extent a double lesion. Not only is there a failure of power in the heart and arteries, but there is also a *failure* in the capillary system which impedes the free passage of the blood. We may call it an *atony* of the walls, a want of resiliency; they dilate before the current of blood, and the simplest experiments in passing fluid through a vulcanized rigid rubber tube, and a thin, elastic one, will be conclusive as to the importance of this defect. Now the capillary circulation is under the influence of the sympathetic system of nerves, as is the heart and larger vessels, and a remedy that will influence one will influence the other. Admit this proposition and see where we are placed! If the common doctrine of sedation is true, then the remedy which temporarily depresses the action of the heart enfeebles the capil-

lary system of vessels, and renders it difficult for the blood to pass through them. If you are ever so unfortunate as to see a case of poisoning by veratrum viride, you will see as marked evidence of this obstructed capillary circulation, as in a case of cholera, or take that partially *toxic* action which reduces the pulse in a couple of hours to fifty beats per minute, and there will be no mistaking this feature.

519. On the contrary, if in medicinal doses they increase the power of the heart and arteries, acting through the sympathetic system of nerves, through the same channel, they will give strength to the capillaries, and thus aid in the free passage of blood through them. They do not overstimulate and thus lead to subsequent exhaustion, but their influence is quiet and leads to better nutrition, and hence to an increase of power. As a patient is kept under the influence of these remedies we find a real increase of power, and the tendency to excited action grows less and less. These effects of aconite and veratrum may be obtained in chronic diseases, and are fully as marked as from digitalis.

520. It is reasonable to suppose that the impairment of nutrition and secretion is principally dependent upon the derangement of the capillary circulation rather than upon the excitation of the heart and larger vessels. We can readily see why these functions should be arrested in fever. As the re-establishment of secretion and nutrition are the principal objects of treatment, and indispensable to recovery, the reader will be enabled to place a proper value on those remedies that correct this lesion.

521. *Passive General Hyperæmia.*—With the views I have just expressed in regard to the capillary circulation in *active* hyperæmia, it will be difficult to define this class of cases. Indeed we will find in practice that it is sometimes difficult to determine those in which there is the ordinary free circulation of fever, and those which have the retarded circulation that we might term *capillary congestion.* Every practitioner recognizes such a distinction, and speaks of the latter class as *congestive;* it is this condition that I wish to designate by the heading.

522. In this case, as in the preceding, there is a real loss of power in the heart and arteries, and in consequence of this and in proportion to it, we have an accelerated action—frequent pulse. In some cases this accelerated action is forcible, as in the *active* condition, but in the more marked cases there is evidence of feebleness in both heart and arteries. We notice as soon as the finger is placed on an artery, that the impulse of the heart is weak, and the soft, open character of the pulse shows the debility of the artery.

523. But it is not so much with the heart and larger vessels as with the capillary system that we are concerned, as it is here there is the greatest lesion. Those minute vessels have so lost their resiliency that the current of blood through them is very sluggish, and in the severer cases, and for some time preceding death, it almost entirely ceases in some parts. In this class of disease we notice an increase of this in certain organs and parts, as in the brain, lungs, liver, kidneys, etc., and these parts are said to be congested. Now, the general capillary congestion is the same in kind, and differs only in degree from the local lesion.

524. The symptoms of this condition are those of inaction or loss of functional activity. There is not the same amount of heat developed, and this is especially wanting in parts distant from the center of circulation. Waste of tissue, as well as its removal, is also retarded or entirely arrested, and the tissues die in their place, and are not removed. An inactive condition of the nervous system is a marked feature, giving that dullness and hebetude in which the patient does not seem to realize his condition, or care whether he lives or dies, and which finally passes into coma, or complete unconsciousness.

525. *Treatment.*—There are three plans of treatment which may be employed in these cases, and each of them offers some advantages. In the first we endeavor to arouse the nervous system, and, by a powerful action upon some one organ or part, and from this on the general system, overcome the capillary congestion. The most efficient means of this class is the use of emetics.

A thorough, active emetic will almost invariably stimulate the sympathetic nervous system to action, and for the time being, at least, will give a free circulation. For this purpose it is frequently employed in congestive fever, in malignant variola, rubeola, and scarlatina, especially in those extreme cases in which the eruption fails to appear, or where there has been a retrocession. It is a very certain means, and one which should not be neglected in severe cases. Acting in the same manner, but with much less influence, cathartics are sometimes administered for the same purpose. To be effectual they need to be stimulating, and so combined as to influence the entire intestinal track. Counter-irritation is also employed in this first plan, and though feebler than either of the other means named, it can readily be associated with them.

526. The second plan of treatment is the internal and external use of stimulants, the object being to arouse the nervous system, and through this obtain a better circulation. Alcoholic liquids, with some of the vegetable stimulants, are generally employed for this purpose, and, as special stimulants to the nervous system, quinia and strychnia. The external means consist in the use of dry heat, friction, and the application by friction or otherwise of topical stimulants.

527. The third plan proposes, by the use of specific medicines acting through the sympathetic system of nerves, to restore the capillary circulation. I have already stated that the action of aconite and veratrum in small doses had this influence, and in the milder cases they will be sufficient. They may also be connected with the means named in the second plan, and together will make a very efficient means. There are four remedies that exert a more marked influence than these, and may be appropriately called *specifics;* but one of these—belladonna—has been thoroughly tested, so that we can apply it in practice. Brown-Sequard first determined this influence of belladonna, and described it as causing contraction of capillary blood-vessels. A large clinical experience by many observers has proven the correctness

of his conclusions, and I employ belladonna for capillary congestion with as much certainty as I use quinia for ague.

LOCAL HYPERÆMIA.

528. We will use the term hyperæmia in the same sense as having reference both to the total amount of blood and the amount in a part in a given time. Local hyperæmia may be *active* or *passive*: the first is known as *determination of blood*, and the second as *congestion*.

529. *Determination of Blood.*—When we speak of determination of blood we recognize that condition in which there is an active circulation in the part, with an increased quantity of blood. In other words there is an increased circulation *to, through*, and *from* the part. The cause of determination of blood is an irritation of the part itself, according to the old latin maxim, *ubi irritatio ibi fluxus.* It bears a very close relationship to inflammation, and it has the same cause, and always forms the first part of that lesion. Any irritation of a part will give rise to this derangement of the circulation, and of course its intensity will be proportionate to the cause.

530. If we examine this process in the web of a frog's foot, we will find it composed of the following parts. (The method I adopt in these examinations is to place the web on glass, and confine it in the usual way by cork, and use dilute acetic acid with a camel's-hair pencil to produce the irritation.) Immediately following the application of the irritant the capillaries *contract*, and if care is used not to produce too great an effect this contraction is very marked, and forcibly illustrates the fact that the capillaries are capable of contraction and dilatation, as was described in the previous section. This contraction is brief, but even while it lasts we observe a hurrying forward of the blood to the part, and the red discs move more rapidly through the capillaries. Soon, however, the contraction ceases, and the vessels become larger than they were in health. The acceleration of the blood still increases,

and we observe the arterial twig pulsating more forcibly, and sending a larger and more rapid stream into the part. And in each capillary there is not only an increased quantity of blood, but the current seems excited, though if we watch it carefully we will find the current is *not* more rapid than in health; in many cases, indeed, it is less. Still from the dilatation, a larger amount of blood is passing through the capillaries, and the veins gathering it up convey it away. As there is an increased number of red discs in the part it seems flushed or reddened.

531. When the determination is but slight there is always an increase of function, but when marked there is no normal functional activity. But in place of this we have an excitation, marked by increased heat and increased innervation. Occasionally there is an overaction of an organ or part that may be confounded with normal function, as when there is diarrhea from determination to the intestinal canal, increased flow of urine from determination to the kidneys, etc. But if these discharges are examined, it will be found that they do not represent functional activity.

532. In the treatment of disease we frequently excite moderate determination of blood to increase functional activity. Thus, for example, the stimulant diaphoretics increase secretion of the skin because of their power to increase the quantity of blood circulating in it, and many diuretics and cathartics act in the same manner. We improve the appetite and digestion by such remedies as stimulate an increased circulation of blood in the stomach; and we gain better or at least more active innervation by the employment of remedies that cause slight determination to the nervous centers. It is important to thoroughly understand this point, as a majority of remedies influence special parts by their power of stimulating these parts and increasing the circulation.

533. When determination of blood continues for some time the part becomes greatly enfeebled, and as its nutrition has been impaired or suspended during this time, its complete recovery is tardy. Occasionally a *flux* occurs from this cause, and by *its* continuance protracts the exhaustion. We have examples of this in

diarrhea, and in some cases of diabetes insipidus. *Dropsy* also results from the same cause. Indeed, in this case the dropsical effusion from serous membranes commences and continues during the determination. Possibly a majority of cases of dropsy of the cavities has this cause, and recognizing it, the irritation and determination are arrested as a preliminary to removing the effused fluid.

534. In some cases determination of blood is the cause of hemorrhage, the increased amount of blood in the part causing its vessels to give way. We see examples of this in menorrhagia, epistaxis, hematamesis, and occasionally in hemoptysis. These causes may usually be recognized by the excitation of the part previous to the discharge of blood, and by the *active* character of the hemorrhage. Recognizing its cause, our remedies will be directed to a removal of the irritation and increased circulation.

535. *Treatment*—The older methods of practice were based almost exclusively upon the theory of revulsion, and by producing an excitation of some other and less important part, it was expected to draw the blood away from that originally affected. Thus a brisk cathartic, rubefacients, and vesicants acted alike in this direction. Depletives are also regarded as important, and in the olden time blood-letting was the chief of these as it was the most effective. Free purgation, with diuresis, acted in the same manner, and in severe cases usually followed the drawing of blood.

536. As regards local measures, there seems to have been no settled plan of treatment. Cold and hot applications would be made in similar cases, and alternated in the same case, providing the first used did not seem to answer the purpose. In the same manner stimulant and sedative applications would be employed and alternated. The local medication was and *is* purely empirical, and that the poorest kind of empiricism, because it is not based upon continuous success.

537. The simplest plan of treatment in these cases, and, as I believe, a rational practice, is to place the patient upon small doses of aconite and veratrum, and by the use of external stim-

ulants and heat restore a normal circulation to the extremities and surface; with an *equal* circulation the determination is certainly at an end. Following this, secretion should be promoted, and, if necessary, remedies given to act upon the three principal emunctories. In some cases we have special remedies to control determination, as when to the brain we administer gelseminum. I think this remedy is as specific in irritation and determination of the blood to the brain in children, as quinia is in ague. The local means will vary in different cases; but as a general rule mild sedative applications are preferable.

538. *Congestion.*—Passive local hyperæmia, or congestion, is that condition in which there is a larger amount of blood in a part, with its motion impaired. There are three causes that may give rise to congestion, and many times the success of treatment will depend upon determining which of these has caused it. First, it may be caused by an irritation of a part, and the part being previously enfeebled, or enfeebled by the active cause, prevents that free circulation characteristic of determination, and thence capillary *stasis*. In this case the irritation determines a larger amount of blood to the part, but it does not pass freely through it. Second, it may be produced from simple debility of a part, without other change in the circulation; in this case there is simple stagnation of blood in the dilated capillaries. It may be expressed in this way: A normal amount of blood being sent to a part, it circulates slowly through it, the dilated capillaries being constantly filled with blood. In the third case the congestion is dependent upon an obstruction to the circulation from a part, as when veins are pressed upon by growths, or inflammatory exudation, or, as we occasionally witness, by the gravid uterus; in this case the congestion is mechanical.

539. In the first two, which furnish the real congestion as we meet with it in disease, it will be noticed that debility of the part is a prominent element; indeed, congestion can not exist without it. Necessarily with this capillary debility there will be impaired or suspended nutrition, and impaired or suspended

function; and as the congestion increases there is molecular death of the part without renewal, and also impairment of the vitality of the blood.

540. When we view a congested part with the microscope, we do not find an increased flow of blood *to* it, *through* it, and *from* it, as in determination; but, on the contrary, the capillaries seem more dilated, and at points somewhat sacculated, and they are filled to repletion with blood that has a very slow movement. In determination we recognized an activity of movement other than that which carried the red corpuscles through the vessels; it might be compared to a freshet in a rapid stream, in which there was a turbulence in the current, and a passing from side to side, and occasional eddying, of the floating material, in addition to the forward movement. In congestion we are reminded of a sluggish stream when filled by recent rains; we see that the stream is full, but have difficulty in determining the direction of the current until after we have observed it for some time.

541. Fluxes are common from this condition of the circulation. We have most marked examples of this in asthenic diarrhœas, where the discharge is almost wholly dependent upon this impairment of the capillary circulation. We have another example in the profuse discharges of mucus which attend congestion of the Schneiderian mucous membrane, and occasionally from the bronchial and intestinal mucous membranes.

542. Hemorrhage also has its origin many times in congestion, though I can not agree that there is an osmosis of blood from the vessels. I think it conclusively proven that hemorrhage is *always* from ruptured vessels, as there are no natural openings or interspaces in the walls of blood-vessels through which the red corpuscles could pour. Congestion favors hemorrhage, because the vessels are enfeebled, and there is increased pressure from the volume of blood, and in consequence of this they are ruptured on free surfaces. It is only in extreme cases that we find hemorrhage when the capillaries receive support on all sides from the tissues, and in these *somatic* death is progressing. We have examples of

this in *purpura hemorrhagica*, in the severer cases of *scorbutis*, and in the advanced stage of fever in the formation of *petechiæ*.

543. Dropsy is very frequently dependent upon congestion. The stasis of blood in the capillaries is the very condition that favors exudation of water, for the vessels are relaxed and filled to repletion, and while there is the same force exerted in the propulsion of blood, they have neither the power to resist it nor to aid its motion through to the veins. All *asthenic* dropsies are associated with this condition of the circulation, and a rational treatment looks to the re-establishment of a normal capillary circulation. If this can be done, the vessels are placed in condition to re-absorb the effused fluid, at the same time that further effusion is stopped.

544. The symptoms of congestion are usually quite plain. In addition to loss of function, there is a feeling of weight and oppression of the part, and if there is pain, it is dull, heavy, or tensive. There may or may not be an increase of temperature; usually in extreme cases the temperature is much lessened.

545. *Treatment.*—The treatment of congestion will vary according to the cause, and the part affected; but in its general outline it will be the same in all cases. An increase in the quantity of blood in one part necessitates a deficiency in some other, and we would, therefore, expect that if we could *equalize* this, the congestion would be at an end. A laugh will not deter me from applying this term to the circulation, for it is one of the simplest and best established facts in therapeutics; indeed, the principal use of counter-irritation is based upon it.

546. We have some very familiar examples, and those who laugh may very easily test the matter on their own persons. A person is suffering from congestive headache, and invariably the feet and legs are cold; in such case the use of a stimulant foot-bath for half an hour gives relief, and, very evidently, by restoring the circulation to the lower extremities, where it was lacking, and thus removing the blood from the head, where it was in ex-

cess. A patient is suffering from *congestive* (asthenic) diarrhea; the extremities, and sometimes the whole surface, is cold from feeble circulation. One of the most efficient plans of treatment is, to place a sinapism over the abdomen, stimulants to the extremities, and dry heat to the whole surface. Just so soon as a normal circulation is restored to the surface and extremities, in this case, the diarrhœa is checked. When the congested part is superficial, the use of stimulants and rubefacients immediately over it is sufficient, in mild cases, for its removal.

547. Where some important part or organ is suffering from recent and severe congestion, we prefer those means which will arouse the entire circulation, and by getting a vigorous action of the heart, and free distribution of blood through other parts, we relieve the congested organ. The most efficient means in this direction is the use of a prompt and thorough emetic. It should not be given so as to simply produce nausea and retching, as is so common, but that forcible expulsive effort which thoroughly empties the stomach, and, in most cases, causes a discharge of biliary matter. Wherever a congestion may be, if recent, this means will relieve it if it is possible for the patient to recover.

548. The *specific* remedies for congestion, thus far, are two in number—belladonna and lobelia. We have a marked example of the action of the first in congestive headache, which is speedily relieved by small doses of the remedy. Its local action in this direction is pretty generally recognized, and we find it recommended in those cases in which the circulation is sluggish and feeble. We have a marked example of the action of lobelia in congestion of the lungs in infants, which it speedily relieves. In congestion of the lungs in the adult, even those severe cases known as *pulmonary apoplexy*, I have seen a single dose of a half-teaspoonful of a tincture of the seed give prompt relief. Its local application is just as satisfactory, and shows clearly the specific character of the medicine.

549. We have heretofore (523) seen that in that general torpor of the circulation that we designated as *passive general hyperæmia*

there was also a tendency to special congestions. It was that condition that gave general dropsy, and such condition is observed, to some extent, in all passive dropsies. In such cases, those means which will invigorate the entire circulatory system are of marked importance. Not only do we desire to stimulate absorption of the fluid, but by giving the patient an appetite, restoring his digestion, and renewing his tissues, we expect to place him in such condition that it will be impossible for a dropsy to occur.

CHAPTER VIII.

INFLAMMATION.

550. WE study inflammation in connection with derangements of the circulation, because it forms the principal part of the lesion, and upon which all the other phenomena seem to be based. Dr. Williams defines an inflammation as a *local hyperæmia, with the movement of the blood partly increased and partly diminished*, and in so far as the lesion affects the capillary circulation the definition is correct. We must look beyond this, however, for this change in the circulation occurs in tissue which has an inherent vitality, and which is easily influenced by change of condition; and it is not really the condition of the circulation that we care for, but the condition of the tissue in which the lesion occurs.

551. I think I do not err in stating that simple lesion of function or circulation will not produce inflammation, but there must be a change in the tissue itself, either affecting its nutrition or its waste. And it is this change in the condition of the tissue that occasions the derangement of circulation, as well as all the attendants and consequences of it. In surgical practice we constantly observe the evidence of this. It is the injury to tissue that causes inflammation, whether the injury be purely mechanical or the rusult of other disease. In confirmation of this view, I will make a quotation from Virchow:—

"*Irritation* must, I believe, be taken as the starting point in the consideration of inflammation, and it is because Broussais and Andral regarded the matter in this light, that I consider the views advanced by them to be the most correct. We can not

imagine inflammation to take place without an irritating stimulus, and the first question is, what conception we are to form of such a stimulus.

"We have already seen that the irritation may, in general, be traced to one of three different sources, according as it is a functional, nutritive, or formative irritation which has taken place. Now, there can be no doubt but that functional stimuli do not play an essential part in inflammation, and for the simple reason that—a point upon which all the more recent schools, at least, are agreed—to the four characteristic symptoms *lesion of function* must be added.

"If there be a disturbance of function in inflammation, this presupposes that the inflammatory stimulus must be of such a nature as to cause changes in the composition of the part, which render it less capable of performing its functions. Nobody would expect a muscle which is inflamed to perform its function normally; every one supposes that the contractile substance of the muscle has thereby experienced certain changes. Nobody would expect an inflamed gland-cell could secrete normally, but we should look upon the disturbance of secretion as a necessary consequence of the inflammation. Nobody could expect an inflamed ganglion-cell or nerve to discharge its functions, or normally to respond to stimuli. The conclusion, therefore, that must, in accordance with the commonest experience, be necessarily drawn from all this is, that changes must have occurred in the composition of the cellular elements altering their natural functional power. Such changes, when they occur after the application of stimuli which are not powerful enough to destroy the parts at once, or to exhaust their functional power, are only possible when the stimuli are either nutritive or formative. And in fact this conclusion is confirmed by what occurs in inflammation. For, nowadays we find the view is already pretty generally spread, that in inflammation we have in the main to deal with a change in the act of nutrition, nutrition being here indeed regarded as embracing the formative and nutritive processes."

552. If now we examine that form of the disease that is classified as *idiopathic* in contradistinction to surgical, we will find additional evidences of the truth of these views. An inflammation of the lungs is caused, as is said, by cold; that is, he has been exposed to sudden alterations of temperature, which enfeeble circulation in the skin, diminish its secretion, and cause this blood to accumulate in the lungs. What is the initial lesion here? Certainly it is not difficult respiration, nor derangement of the nervous function, but it is a change in the nutrition and waste of the elemental tissue. From this springs the changed circulation, and innervation, and other parts of an inflammatory process. The injury to this part is just as real, though not visible to the naked eye, as an incision with the surgeon's knife.

553. The initial lesion is the same, no matter where the inflammation may be situated, or the cause that produced it. It is always and necessarily of the tissue itself, and we only gain a proper appreciation of it when we think of the ultimate elements of tissue—the formative cells—and when we trace the various steps in its progress and ending, we will find them having reference to, or rather involving these elemental structures.

554. Any cause by which cell-growth may be influenced is a possible cause of inflammation. Even those agencies that in moderate degree on the sound body exert such influence as conduce to normal nutrition, may, if increased, or the condition of the body be changed, cause this lesion. In a majority of cases we can readily recognize the cause that has impaired the vitality of tissue, because it is palpable to our senses, but as there are many influences that affect nutrition and waste that are impalpable, we must not ignore them because we can not see or feel them.

555. *Irritants* that induce inflammation may be divided into three classes, *vital*, *chemical* and *mechanical*, and each of these may be appreciable to the senses, or may be beyond this, unless aided by artificial means. We term those irritants vital which only influence living tissues, in contradistinction to those which effect a change whether the matter be living or dead. In this class are included all local stimulants, rubefacients, and vegetable

vesicants, as mustard, capsicum, the essential oils, cantharides, etc., for these exert no influence on dead tissue, or indeed upon any organized matter. In the same catalogue we would have to place some of the animal poisons, as the bite and sting of certain insects; but it would not include such poisons as that of the serpent and mad-dog, or the specific animal poisons of small-pox, scarlatina, etc., as these set up a chemical change in dead as well as living matter. A chemical irritant is one which influences organic matter under all conditions, combining with it, or tending to alter or decompose it, as the stronger acids, alkalies, and various corrosive salts. A mechanical irritant is one that injures or breaks down tissues; the finest point of steel produces irritation in this way as much as the surgical instrument.

556. There is one class of vital irritants that deserve special notice, because their influence is so common, and they prove such frequent causes of inflammation. I allude to cold (heat?) and to various animal matters, the product of waste within the body. As we have noticed heretofore, cold is the most frequent cause of idiopathic inflammation, and there is no doubt that its principal action in this direction is an impairment of nutrition. Congestion would seem to be the first result of the cold, and from this the impairment of nutrition. There is no doubt of the fact, however, that there is this impairment of cell-growth, or really of the cells already grown, and there are molecules of tissue that have their vitality entirely destroyed by this cause. The products of waste may excite inflammation in the same manner; their presence as dead matter is an irritant to the living tissue, while their decomposition in contact with these ultimate forms must also prove irritant. I would not be understood as claiming that an inflammation was necessary for the removal of this impaired or broken-down tissue, for it is not. But there must be an increased activity to remove the material, and in exceptional cases, when once started, it continues without control.

557. In examining the causes of inflammation, we can not but be impressed with the fact that they all impair the life—impairment of the life of the part and the life of the individual being

a prominent feature. In some cases this is more and in others less marked, but it is never to be ignored; and the impairment of the life that we notice at the commencement persists throughout the course of the disease. The cause of an inflammation is always, again, an irritant; as in determination of blood, the maxim, *ubi irritatio ibi fluxus*, applying here as well. Thus in all cases we weigh these two results of the cause carefully, determining which preponderates. In some the impairment of the life is greatest, and we have an enfeebled circulation of blood and stasis as the result. In others the irritation preponderates, and we have an active circulation and great excitement as the result.

558. In all cases the treatment will thus be divided into two kinds, or at least there will be two objects in treatment—the one to relieve the irritation and stop the determination of blood, and the other to sustain and improve the life of the part. In some cases the treatment will be almost wholly sedative, in others almost wholly stimulant. But this will be considered hereafter.

559. *Phenomena of Inflammation.*—We study the phenomena of inflammation to the best advantage if we can realize the anatomy and physiology of the capillary circulation, and the relation it bears to the other parts of a tissue. We desire to call to mind first, the minuteness of its distribution—that the intercapillary spaces are not larger than the capillaries themselves, and thus a tissue is but a plexus of blood-vessels. Nutrition and waste are so dependent upon this circulation, that they are to a greater or less extent suspended by its derangement. All functional activity is also dependent upon it, so that when changed as in inflammation this also ceases.

560. The changes in the capillary circulation are readily studied under the microscope, and the web of a frog's foot is used as being the most convenient. If to that portion in the field of the microscope a minute portion of acetic acid is applied, a real inflammation is developed. Immediately on the application of the stimulant the capillaries contract; but this is mo-

mentary, and sometimes is so evanescent as not to be noticed. Following this these vessels are seen to dilate until they become larger than they were in health, and now we see the arterial twig pulsating more forcibly, and carrying a larger amount of blood to the part. The capillaries have a larger amount of blood, and it is in active motion, not only forward, but eddying from side to side. We notice further that certain new vessels are developed, very minute, and passing the red discs with considerable trouble; these were the minute capillaries that in health received liquor sanguinis only. As this disturbance continues we notice that certain portions of the walls of the capillaries seem to give way to the impulse of blood, and they become very irregular in outline and diameter, and in some cases markedly sacculated. Thus far we have described the lesion as one of *determination of blood.*

561. But going beyond this we observe greater irregularities of size, but more especially that the white corpuscles float at the side of the stream, and tend to get stranded. Soon at the central point where the irritation was greatest, they attach themselves to the wall of the vessel, and form a promontory around which the red corpuscles go in single file, even elongating themselves to crowd past. The circulation seems more sluggish, and though the red corpuscles still pass through, yet there is much eddying and to and fro movement. Finally, they no longer pass out of the vessel, but move backward and forward and from side to side, and others being forced in from the arterial side, the capillary becomes quite full and red, and soon the motion of the blood ceases entirely. Thus the arrest of capillary circulation goes on from the center until the boundaries of the inflammation are reached, where we find the movement of the blood preternaturally active as in determination.

562. Thus an inflamed part consists of a larger portion where the capillary circulation is entirely arrested, and a zone where its activity is greatly increased. Though we observe all of these processes in the frog's foot in the course of one or two hours, we are not to suppose they progress so rapidly in ordinary inflammation, or that there is an *entire* arrest of circulation in a large part,

as, for instance, a lobe of the lung. On the contrary, the process that we observe with the microscope in hours frequently requires days, and the *parts* of entire arrest are separated by others in which the circulation still continues. Imagine the circulation entirely arrested in a large part, and you will readily see that it is absolute death; and thus when we speak of such arrest in minute vessels, it is in correspondingly minute parts; but through the mass the small arteries still carry blood, and here and there is slight capillary circulation.

563. We can not see this process further, only that we observe change in the contents of the capillaries, and when the arrest of circulation continues for some time, a partial breaking down of the red corpuscles takes place. But if the inflammation progresses to suppuration, we may sometimes witness the formation of pus globules in the intercapillary spaces, but the field of vision soon becomes indistinct, and we see nothing further.

564. We may, however, examine that termination of inflammation which is named *resolution*. In this case the re-establishment of the circulation commences from the circumference and progresses toward the center. One after another we notice returning movement in the contents of the vessels, and oscillation and tendency to forward movement in the red corpuscles, and finally becoming loosened they pass out one after another, and the white corpuscles are detached and float off. Following immediately in the wake of the impacted contents, comes a fresh supply of blood from the artery with new discs, and soon the circulation is as free as in health. Thus the process continues until the entire capillary circulation in the inflamed part is restored.

565. The symptoms of an inflammation, as given for centuries, are *pain, heat, redness, and swelling*. These are considered so indispensable to the lesion that when they are present it is positive there is inflammation; when they are absent of course it can not be. We have already seen that in a small degree each of these symptoms might be dependent upon determination of blood, but when marked we must agree with the older writers that it is a real *phlogosis*. But is there any resemblance here to a process

of burning, which its name would imply, and which many persons believe? It resembles it to this extent: that there is increased heat and destruction of the vitality of tissue, but no combustion.*

566. We account for these four symptoms in this way: *Pain* arises from excitation of the nerves of the part by the increased amount of blood in it, by the tension of the nerves incident to

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* "*Nature and Causes of Inflammation.*—The several parts of the inflammatory process have been considered. They are, increased fullness of the blood-vessels, with retarded movement of the blood; swelling; pain, or other morbid exalted sensation; increased heat; exudation of lymph from the blood-vessels; defective nutrition of the proper elements of the affected part. The first five are often spoken of as the signs of inflammation, the last two as its effects; but these terms have reference only to the former being more transitory phenomena than the latter; they are all, when they concur, constituent parts of the disease; but the latter are less quickly recovered from than the former.

"It would not be judicious, I think, to refuse to call that process inflammation, in which any one of the conditions just enumerated is absent or unobserved. Swelling, or pain, or, much oftener, increased heat, may be inappreciable in tissues that we may still rightly call inflamed, while the other evidences of the disease are present. The same may be said of increased or altered exudation from the blood-vessels. No such exudation is observed in the diseased cornea or articular cartilages; but it would be unreasonable, in the case of an inflamed eye, to say that the changes are due to inflammation in every part but the cornea; and to call the process leading to the ulceration or leucoma of the cornea by a name different from that which we give to the coincident and similarly excited process in the other tissues. So, during the inflammation of a joint, it would be, at the least, inconvenient to say that all the tissues are inflamed except the softening or ulcerating cartilages. The progressive degeneration of tissue is, probably, never absent when the other parts of the inflammatory process exist; but, in quickly transitory cases, it is often inappreciable. The altered state of the circulation may be unobserved, but it is probably always present; for in the case of the parts that have no interstitial blood-vessels, inflammation may still be attended by enlargement of those of adjacent parts on which their ordinary nutrition depends.

"The conclusion, then, may be, that in what may be regarded as well-marked, or typical examples of inflammation, all the characters I have enumerated are present as concurrent parts of the disease; but that the same name should not be refused to diseases in which any one of these parts is absent or unobserved, especially when its absence may be explained, as in the case of inflamed cartilages, by some peculiarity of tissue or other condition of the disease. I think it would not be right to call any process inflammation in which there is neither an exudation of

the swelling, and by the destructive process progressing in the tissues. *Heat* is caused in part from an excess of blood, and in part from increased oxidation. The principal manifestation of heat, however, in superficial inflammation, is not from a real increase in its development, but rather from its retention from derangement of the skin. As has been heretofore named the skin regulates the temperature, excessive heat being removed by evap-

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lymph (*i. e.* of material capable of such developments or degenerations as I have described), nor a deterioration of a proper tissue of the affected part; even though the other characters of the disease might be present. But, really, whatever rule of nomenclature be adopted, we may expect to meet with many cases in which we shall doubt what name to give to the processes which we watch, or of which we see the results. There is neither here, nor in any other part of pathology, anything like the unity or circumspection of species, by which the zoologist, whose nomenclature pathologists are prone to imitate, is justified in attaching to each specific name the idea of several constant and unalterable characters in the beings to which it is assigned.

"An examination of the very nature of the process of inflammation may best be made in the form of a comparison of its effects with those of the normal process of nutrition. And this comparison may be drawn with two principal views, namely, to determine: 1st, How the effects of inflammation differ, in respect of *quantity*, from those of the normal process; and 2d, how they differ from the same, in respect of *quality* or *method*.

"The decision on the first of these points may seem to be given in the term 'increased action,' which is commonly used as synonymous with inflammation. As used by Mr. Hunter, this term was meant to imply that the small vessels of an inflamed part are more than naturally active, in formation or absorption, or in both these processes. This is, probably, the meaning still generally attached to the term by some; while, as employed by those who believe the vessels are only accessories in the work of nutrition, the expression, 'increased action,' may be used to imply merely increased formation, or increased absorption. In either, or in any, meaning, however, the term seems to involve the idea of an increased exercise of vital forces, *i. e.* of those forces through the operation of which the various acts of organic formation are accomplished. But, if 'increased action' is to imply this, the description of the process and effects of inflammation shows that the term can not be properly used, without some limit or qualification.

"If we consider the quantity of organic formation effected during the inflammatory process, in the proper substance of the inflamed part, it is evidently less than in health. All the changes described in the last lecture are examples of diminished or suspended nutrition in the tissues of the inflamed part; they are all characteristic of atrophy, degeneration, or death. The tissues become soft, or quite disorganized; they are relaxed and weakened; they degenerate, and remain lowered at once in structure,

oration from the surface. If an inflammation occurs contiguous to the skin this insensible transpiration from the surface is diminished or arrested, and hence a marked increase of heat. The heat of an inflamed part, however, never exceeds that of the blood. *Redness* of a part, is from an increased amount of red corpuscles in its capillaries, as we have seen to be the case when describing the microscopic character of the lesion. *Swelling* arises

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chemical composition, and functional power: or else, after degeneration, they are absorbed, or are disintegrated, or dissolved, and cast out; they die in particles or in the mass. During all the processes of inflammation there is no such thing as an increased formation of the natural structures of the inflamed part; they are not even maintained; their nutrition is always impaired, or quite suspended. It is only after the inflammation has ceased that there is an increased formation in some of the lowly organized tissues, as the bones and connective tissue.

"So far, then, as the proper substance of the inflamed part is concerned, there appears to be decreased action; that is, decreased formation. There may be, indeed, an increased absorption; but this is also, in one sense, characteristic of decreased exercise of vital force; since all absorption implies a previous degeneration of the part absorbed. Nor can we justly call this, in any sense, 'increased action,' till we can show how absorption is an action of vessels.

"Thus far, one of the constituents of the inflammatory process, one of the characters in which it differs, in respect of quantity, from normal nutrition, is a defect in the nutrition of the proper substance of the inflamed part.

"But it is characteristic of the complete process of inflammation, that, while the inflamed structure itself suffers deterioration, there is a production of material which may be peculiarly organized. Here, therefore, may be an evidence of increased formation, of increased action.

"Doubtless, in relation to the productive part of the inflammatory process, the expression 'increased action' may be in some sense justly used; for the weight of an inflamed part, or of the material separated from it, may be much increased by the formation of organized matter. But the quantity of organized matter formed in an inflammation must not be unconditionally taken as a measure of increase in the exercise of the vital forces; for it is to be observed, that the material formed presents only the lowest grades of organization, and that it is not capable of development, but rather tends to degeneration, so long as the inflammation lasts.

"It may be but a vague estimate that we can make of the amount of force exercised in any act of formation; yet we may be sure that a comparatively small amount is sufficient for the production of low organisms, such as are the fibrinous and corpuscular lymphs of inflammation. The abundant production of lowly organized structures is one of the features of the life of the lowest creatures, in both the vegetable and animal king-

from two causes: First from the increased amount of blood in the part, distending the capillaries to their full capacity; and second, from the effusion or exudation into intercapillary spaces.

567. Some of the general symptoms of inflammation may be noticed here. I doubt whether it is possible for an inflammation to exist without influencing to some extent the entire body. In slight cases this is hardly noticed, but where any considerable

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doms. And in our own cases, a corresponding abundant production is often noticed in the lowest states of vital force; witness the final inflammations, so frequent in the last stages of granular degeneration of the kidneys, of phthisis, of cancer, and other exhausting diseases. In all these, even large quantities of the lowly organized cells of inflammatory lymph may be formed, when life is at its last ebb. And with these cases those correspond which show the most rapid increase of tubercle and cancer, and of lowly organized tumors, when the health is most enfeebled, and when the blood and all the natural structures are wasting.

"From these considerations we may conclude that the productive part of the inflammatory process is not declaratory of the exercise of a large amount of formative or organizing force; and this conclusion is confirmed by observing that development, which always requires the highest and most favored exercise of the powers of organic life, does not occur while inflammation lasts. The general conclusion, therefore, may be, as well from the productive as from the destructive effects of the inflammatory process, that it is accomplished with small expenditure of vital force; and that even when large quantities of lymph are lowly organized, such an expression as 'increased action' can not be rightly used, unless we can be sure that the defect of the formative power, exercised in the proper tissue of the inflamed part, is more than counterbalanced by the excess employed in the production and low organization of lymph.

"It may be said that the signs of inflammation are signs of increased action. But these are fallacious, if, again, by increased action be meant any increased exercise of vital force. The redness and the swelling of the inflamed part declare the presence of more blood; but this blood moves slowly; and it is a quick renewal of blood, rather than a large quantity at any time in a part, that is significant of active life. An abundance of blood, with slow movement of it, is not characteristic of activity in a part; it often implies the contrary, as in the erectile tissues, and the cancellous tissue of bone.

"The local increase of heat is too inconstant to afford ground for judging of the nature of inflammation. When manifest, it is not, I think, to be exactly compared with that of an actively growing part, or of one which is the seat of 'determination' of blood, or of 'active congestion.' In these cases the heat is high, chiefly because the blood, brought quickly from the heart, is quickly renewed; but, in an inflamed part, the blood is not so renewed; it moves more slowly. The heat may, indeed, be in some measure ascribed to this condition; for the quickly moving blood around

amount of tissue is involved the general symptoms are prominent. These are referable to three sources: The influence of the inflammatory process on the nervous system, on the circulation of the blood, and on the condition of the blood. The excitation of the nerves of the part manifests itself in the nerve-centers as *pain*, and to the extent of this depresses the innervation. It also modifies the nutrition of the nervous system, so that the long

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the inflamed part may communicate its heat to that which is moving more slowly. But the proper heat of inflammation (I mean that which is measurable by the thermometer) can not, I think, be wholly thus explained. Some of it is, probably, due to the oxidation of the degenerating tissues; a process which we might safely assume to be rapidly going on in the more destructive inflammations, and which is, indeed, nearly proved by some of the evidences of the increased excretion of oxidized substances in inflammations, especially by the increase of phosphates in the urine during inflammation of the brain. It is far from proved, indeed, that this source of heat is sufficient for the explanation of the increase in an inflamed part; and it may be at once objected that we have no evidence that the hottest inflamed parts are those in which the most destructive processes are going on. Still, in relation to the question, how far the increased heat is a sign of the quantity of formative force that is being exercised, we may argue that, as the general supply of heat in our bodies is derived from oxidation or combustion of wasted tissues or of surplus food, so in these local augmentations of heat, the source is rather from similar destruction of organized substances than from increased formation of them. If it be so, the increased heat will give no ground for regarding the inflammatory process as the result of a greater exercise of formative force than is employed in ordinary nutrition; none for speaking of it as increased nutrition, or increased action. Rather, this sign may be added to the evidences that the inflammatory process presents, of diminished formative force, and of a premature and rapid degeneration, in the affected part.

"In thus endeavoring to estimate the difference between the normal and the inflammatory modes of nutrition in regard to the quantity of formative or other vital force exercised in them respectively, I have also stated the chief differences in relation to the quality or method of nutrition.

"The most general peculiarity of the inflammatory method is the concurrence of the two distinct, though usually coincident, events of which I have spoken at such length; namely, 1st, the impairment or suspension of nutrition of the proper substance of the inflamed part; and 2d, the exudation from the blood of a material more than sufficient in quantity for the nutrition of the part, but less than sufficient in its capacity of development.

"By these concurring, it is plainly distinguished from the normal *method* of nutrition, The same combination of events establishes the

duration of pain leads to permanent debility. The febrile disturbance may in part be traced to this cause

568. But beyond the cognizance of our senses, there is another system of nerves and centers that is still further involved. Every capillary vessel has its sympathetic nerve which controls the circulation, and also, to some extent, the nutrition and waste of the part. It will be noticed that the inflammatory process is a lesion

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chief differences between the inflammatory and every other mode of nutrition in a part. Thus, from all the forms of mere atrophy or degeneration, the inflammatory process, at least in the typical examples, is distinguished by the production of the lymph, which may be organizing, even while the proper tissue of the inflamed part is in process of atrophy, degeneration, or absorption. So far as the tissues inflamed are concerned, some inflammations might be classed with atrophies or degenerations; but the concurrent production of lymph is distinctive of them.

"On the other side, the inflammatory mode of nutrition is distinguished from hypertrophy by the failure of the nutrition of the inflamed part itself. So far as mere production and formation of organisms are concerned, some inflammations might be paralleled with hypertrophies; but the organization of the lymph commonly falls short of that proper to the part in which it is exuded; and the substance of the part, instead of being augmented, is only replaced by one of lower organization.

"And, lastly, from the production of new growths, such as tumors, the inflammatory process is distinguished by this—that its organized products, though like natural tissues of the body, are usually infiltrated, fused, and interwoven into the textures of the inflamed part; and that, when once their development is achieved, they have no tendency to increase in a greater ratio than the rest of the body.

"I am well aware that these can be accepted as only the generally distinguishing characters of the complete inflammatory process. Cases might be easily adduced in which the border lines are obscured; inflammations confounded on one side with atrophies, on another with hypertrophies, on a third with tumors, and on others, with yet other local phenomena of disease. But the same difficulties are in every department of our science; yet we must acknowledge the value of general distinctions among diseases even more alike than these are.

"The case that I have chosen for illustrating the general nature of the inflammatory process is one representing the disease in its simplest form and earliest stage, manifesting only the formation of lymph, and such a change as the softening or absorption of the inflamed part. This is but the beginning of the history; but, if the inflammation continues, or increases in severity, all that follows is consistent with this beginning; all displays the same double series of events, the same defective nutrition of the part, and the same production of low organisms. But these additions are observed: The part is more and more deteriorated, and perishes in the mass, or in minute fragments; the newly-organized products, not

of these three functions, and therefore the influence on the sympathetic nervous system must necessarily be marked. Now, when we consider that this system of nerves controls the circulation, digestion, the formation of the blood, nutrition, and secretion—in fact, all the purely vital (or vegetative) functions—it will show how the general lesion follows the establishment of the local one.

569. The direct influence on the general circulation is, of

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finding the necessary conditions of nutrition, partake in the degenerative process, and instead of being developed, are degenerated into pus, or some yet lower forms, or perish with the tissues in which they are imbedded."—*Paget, Surgical Pathology*, pp. 293–299.

"*Extension of Inflammation.*—All inflammations, of whatever character, are, in the first instance, strictly local; that is, they begin in, and are confined to, a particular tissue, spot, or point, from which, as from a common focus, the morbid action radiates in different directions, until it becomes, so to speak, general. To illustrate my meaning, let it be supposed that the malady commences at a certain part of the mucous coat of the small bowel, as, for example, in one of the glands of Peyer. After having remained here for a short time, it gradually spreads to the fibro-cellular lamella, then to the muscular fibres, and finally to the peritoneal investment, thus involving the whole in one mass of disease. In erysipelas the same law is observed. Here the morbid action, beginning at a little point of skin, gradually extends to the deeper structures, until, as in the case of a limb, it invades cellular substance, aponeurosis, muscle, vessels, nerves, periosteum, and occasionally even bone. A pneumonia, in its progress, usually involves the pulmonary pleura and the bronchial mucous membrane. These instances will suffice to prove the position here assumed, which is the more important because it presents the characters of a general principle.

"The rapidity with which inflammation extends from one texture to another is too variable to admit of any precise statement; in some instances the time is very short, perhaps not exceeding a few hours, and such cases are, it may be remarked, generally very prone to be characterized by more than usual violence. It must not, however, be inferred from this statement, that the morbid action always spreads from the point originally attacked; for, although there is unquestionably a very strong tendency to this, yet there are numerous exceptions to it. In some cases this limitation is due to the disease itself; in others it depends upon the deposit of plastic matter; while in a third series of cases it is owing to the structure of the overlying tissues, as for example, in the periosteum, which often serves to protect the bone which it surrounds from the encroachment of disease of the soft parts.

"One of the most common modes in which inflammation propagates itself is by *continuity of structure*. The morbid action, once begun, finds it easy to pass along the tissues in which it originated, and hence it often

course, proportionate to the extent and intensity of the local lesion. When small it is not perceptible, but when of a large part it must necessarily influence the entire circulation. As there is more blood sent to the part, some other portion is depressed to this extent; and as there is greater expenditure of power in the circulation, this is either extended to the entire circulation, as in symptomatic fever, or, when the vitality is too much depressed

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spreads rapidly over a large extent of surface, similarity of structure and function favoring the process. By continuity of structure an erysipelas of the skin, perhaps not larger at its commencement than half a dime, spreads in a few hours over an entire limb, or even over the greater portion of the body. In the same manner inflammation is liable to be propagated along the mucous canals, as exemplified in tonsillitis, croup, and other affections of the throat and air-passages, and in the various diseases of the stomach, bowels, and genito-urinary apparatus. In duodenitis the morbid action may readily extend along the choledoch and hepatic ducts to the liver; and in gonorrhœa nothing is more common than for the disease to spread along the seminal passages to the epididymis and testes.

"Secondly, inflammation may propagate itself by *contiguity of structure.* A phlegmonous erysipelas of the skin has a tendency not merely to spread over the neighboring surface, in consequence of its similarity of structure and function, but also to extend in depth, thereby involving cellular tissue, aponeurosis, muscle, and, in short, every other texture within its reach. The tissues mainly concerned in the enterprise are the vascular and connective, the peculiar structure of which renders them highly favorable for the propagation of the morbid action. An inflammation, beginning in the conjunctiva, often in its progress involves the entire eye, simply from the intimate manner in which its different tunics are superimposed upon each other. In the bowel and other mucous canals the same effect is frequently witnessed. In pneumonia, especially in the more violent forms, the disease is rarely confined to the parenchymatous substance, but is almost sure, in time, to spread to the pleura and bronchia. In orchitis, although the inflammation is primarily seated in the tubular structure of the epididymis and testicle, it is by no means uncommon for it to extend to the albuminous coat, and occasionally even to the vaginal. An inflammation of the synovial membrane of a joint often spreads, by virtue of the same law, to the articular cartilage and the head of the bone beneath—contiguity and intimate connection favoring here, as elsewhere, the propagation of the morbid action.

"Thirdly, the extension may be effected through the agency of the *veins* and *lymphatics.* Of the former a good example is afforded by what occasionally happens in venesection, where, apparently from the use of a foul lancet, the inflammation sometimes extends from the little wound in the vessel, at the bend of the arm, as high up as the right auricle of the heart; and the latter by what occurs in chancre, where the poison, taken

for this, there is a corresponding want of power in some other part.

570. The constitution of the blood is affected in all cases, but in some particularly, and to a very great extent. We can make a division of inflammations into *simple* and *specific*. In the first the lesion of the blood is only to that extent that it is impaired by stasis, and by retention of the natural excreta. In the other the inflammation develops a specific poison, which acts upon the blood in the same manner as has been heretofore described. As

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up by the absorbent vessels of the penis, is conveyed by them to glands of the groin, where it causes a hard and painful swelling, constituting what is termed a bubo. In dissection-wounds the absorbent vessels always serve as vehicles for the transmission of the peculiar poison which gives to these lesions their characteristic features. For a short period after the inoculation the poison is apparently latent, when its effects show themselves by one or more red lines extending up the limb as far as the axillary glands, whence, as from a common center, its injurious consequences are radiated over the whole system.

"Of the extension of inflammation by *nervous agency*, or sympathy, a familiar example is afforded in parotitis. In this disease, which attacks chiefly young subjects, the inflammation often suddenly leaves the organ originally involved, and fastens itself upon the testicle, which is then compelled to bear the whole onus of the morbid action. Of the precise manner in which this transfer is effected we are ignorant. That it is not through any direct nervous connection is sufficiently obvious, for every body knows that no such connection exists; hence, as the only plausible explanation left for us, we must conclude that it is brought about by the operation of sympathy, although of the nature of this operation it is impossible, in the present state of the science, to form any just idea. A similar relation exists between the mammæ and uterus, the stomach and lungs, and between the stomach and brain, or rather between the former organ and the arachnoid membrane.

"Finally, inflammation may be propagated by the *blood*. This fluid, as will afterward appear, undergoes various changes in this disease, of which the most important is an increase of fibrin and colorless corpuscles, with a strong tendency of these substances to adhere to the sides of the vessels as they are propelled along with the general circulating mass. The blood, thus altered in its properties, leads to obstruction of the capillaries in different parts of the body, thereby establishing foci of morbid action. It is not improbable that metastatic abscess, or what is now called pyæmia, is generally produced in this way; at all events, this is a more rational mode of accounting for that occurrence than the one which attributes it to the absorption of pus, or the admission of this fluid into the blood, through the agency of open-mouthed veins."—*Gross' Surgery*, page 57.

examples of this form of inflammation I may instance *syphilis*, *gonorrhœa*, *erysipelas*, and malignant pustule.

571. The *symptomatic fever* produced in simple inflammation is very similar to the idiopathic disease in its symptoms, progress, and termination. If the causes named are marked, the fever is severe and protracted; but, on the contrary, if they are slight the fever is mild and evanescent. It will also be noticed that such symptomatic fevers bear a marked relation, in type, to the prevailing fevers of the country If these are periodic, the symptomatic fever will be periodic; if they are continued, it also will be of a continued type. It goes further than this; for if the prevailing fever is *asthenic*, the symptomatic fever will be asthenic, as we have very marked examples when an inflammation occurs at a time when *typhoid* fever is prevailing.

572. The *terminations* of inflammation have attracted much attention; and, in descriptions of the lesion, they always assume an important place. In the older authors, we read of the termination, by *resolution*, by *metastasis*, by *suppuration*, by *adhesion*, by *induration*, by *gangrene*, and by *mortification*. There may have been others, but my memory only recalls these. Really, there are but two terminations—*resolution* and *death*—though there are many *effects* and *results* of inflammatory action, and death may occur in different ways.

573. The *exudation* that occurs in all inflammations demands our study, for to some extent the results of the lesion will depend upon this. These, which may be termed *products of inflammation*, are serum, blood, coagulable lymph, and mucus.

574. *Serum* alone is rarely effused, except in the lowest degrees of inflammation. Still we find many cases in which the exudation may properly be termed *serous*, for the proportion of fibrin or plastic matter is so small as to be of but little use in the process of repair. The characteristic serous exudation is that thrown out from a blister; in eczema, perhaps, it is still serous, but capable of slight organization.

575. Effusion of *blood* can not occur unless there is rupture of the vessels; for, as we have heretofore seen, there is no other way

in which red discs can escape. Occasionally dilatation of the capillaries is such as to give them a very irregular sacculated appearance; and we wonder that they do not give way entirely, as we look at them. In rare cases they do give way, and then we have exudation of blood.

576. *Plastic lymph* is the normal exudation of inflammation, as it is capable of organization for the repair of the part. It has been contended by some that it was fluid fibrin, by others that it was albumen, as persons viewed the fibrin as having a greater or less degree of organization. It was undoubtedly the nutritive material of the blood, that which forms tissue, and this is all that we care to know about it. It is not necessary to speak of the changes to which it is subject; these will be described when we consider the results of inflammation.

577. The exudation of *mucus* is a compound process, and should not be associated with the others. Occurring always from the free surface of a mucous membrane, it takes the form of the natural secretion which lubricates and protects that surface. When we study the history of mucus, we find it to be an albuminoid fluid, bearing a very close resemblance to fibrine. In many specimens the fibrillation is very well marked; and especially is this the case in the mucus produced during an acute inflammation. With this is associated a gelatinous-looking and acting material; and through the whole is distributed numerous mucous cells, which bear a very close relationship to pus-globules. It is this natural secretion which is increased in inflammation of mucous membranes, though it is variously changed in the proportion of water, fibrillation, and mucous cells.

578. The conditions upon which these changes in the exudation material depend are three—namely: The seat of the inflammation, the degree of the inflammation, and the state of the blood.

579. The doctrine of Bichat, and also of Hunter was: "That each tissue had its proper mode and product of inflammation." Paget remarks: "The facts on which it is held that, in general, each part or tissue is prone to the production of one certain form of inflammatory exudation, are such as these: That, *e. g.*, in the ap-

parently spontaneous inflammations of the skin, lymph with corpuscles alone is produced, as in herpes, eczema, erysipelas; that in serous membranes the lymph is commonly fibrinous, and has a great tendency to be organized and form adhesions; that in mucous membranes there is as great a tendency to suppuration; that in the lungs, both fibrine and corpuscles are abundant in the lymph, and the corpuscles have a remarkable tendency to degenerate into either pus cells or granule cells; that in the brain and spinal cord the tendency is to the production of a preponderance of corpuscles that quickly degenerate into granule cells, while in the areolar tissue, both fibrine and corpuscles appear, on the whole, equally apt to degenerate into pus, or to be developed into filamentous tissue."

580. The rapidity of the inflammatory process frequently decides the character of the exudation. When is is very rapid the exudation is usually serous, or if slow and accompanied with a sluggish circulation, it will also partake of this character. If developed moderately, and in a healthy tissue, the exudation will be of plastic lymph. Usually we can predicate our opinion of its plasticity and capacity of tissue-formation from these circumstances, the blood being of good quality.

581. The material of the exudation being derived from the blood, it will necessarily partake of the character of this fluid. If the blood is well elaborated the effused fluid will always be plastic; but, on the contrary, as the formative material in the blood becomes depraved, the exudation has less vitality and capacity for organization, and breaks down easier. We see marked examples of this in the repair of wounds. When the system is in a healthy condition the exudation is readily organized, and forms sound, strong tissue; but let a surgical fever set in, and we find that day by day the exudation loses its plasticity; until, when the tongue becomes brown and sordes appear around the teeth, it is nothing but a putrescent serum.

582. *Resolution.*—We have already examined the termination by resolution as it is seen under the microscope, and found that

it was the inflammatory process reversed; that the capillary circulation was gradually restored from the circumference to the center as it had been suspended. We could not see, however, the process of exudation, nor can we see the removal of the material, yet we know how it is accomplished. The exudation was thrown out in consequence of obstructed circulation, and so soon as this is re-established a process of endosmosis commences from the intercapillary spaces to the current of blood, and it is drawn into the current and carried away. If it has become partially organized the cells are broken up, and if need be, water thrown out to give the exudation the necessary fluidity, and it is then absorbed. Thus, the entire process of resolution may be said to consist in the re-establishment of the capillary circulation, and from this a gradual absorption of the exudation.

583. The nutrition of the part has been suspended during this period, and consequently it is feebler; its vitality has also been impaired by the inflammatory process; so that, although the part is apparently left in the same condition in which it was before the inflammation, yet there is always a change in this respect. It has left, however, its power of reproduction, and as time passes the worn-out cells are removed and new ones take their place, until at length the part is entirely renewed, and with its original vitality. Sometimes this process of renewal is very tardy, and even imperfect, and the normal function of the part is never regained; at others certain parts lose their power to reproduce their kind, and they are replaced with fibrous or other adventitious tissue.

584. We say that the inflammation terminates by resolution, when the irritation causing it has not been sufficient to destroy the vitality of the part. But we must add further that the inflammatory process is itself destructive, and may deprive a part of life when the original irritation was but slight.

DEATH OF A PART.

585. Complete death of a part from inflammation is designated as *mortification*, and the first stage of this is sometimes termed

gangrene, though we had better consider the terms as synonymous. Mortification occurs from two causes: First the severity of the original injury which so impairs its vitality that it is not only incapable of reproducing itself, but even of living for the short time necessary for removal by suppuration. Second, though the injury would not necessitate death, yet the inflammatory process which succeeded it was so severe, and the obstruction to the capillary circulation so great, that death results from this.

586. If the molecular death progresses slowly, and the part loses first its functional activity, its sensibility, and its heat, we have that condition usually designated as gangrene. It is still possible in some cases for this cell-death to be arrested, and though for a long time feeble, the part may eventually reproduce itself. Thus we have remedies recommended for the arrest of gangrene, as the sulphate of zinc, chloride of zinc, yeast and charcoal, etc. Those parts which have died may be removed by the ordinary process of absorption, or by suppuration.

587. The process by which the system removes a dead part is worthy of notice. Frequently mortification progresses for some time, gradually extending its area as the tissues become more and more feeble. During this time the livid discoloration seems to run into and continues with the pallor of the adjacent living tissue. Finally, when this process of death is to be arrested, a vigorous capillary circulation is established in the sound tissue next to the dead. This forms a bright-red line, which is termed the *line of demarcation,* and is always looked for with anxiety, as denoting the arrest of the mortification. With this redness we have all the evidences of an inflammatory process, and there is exudation of lymph towards the dead tissue. In this lymph the pus transformation commences, and as it continues the tissues are dissolved, and the dead is finally severed from the living part.

THE RESULTS OF INFLAMMATION.

588. Under this head we will consider *suppuration, adhesion* and *induration,* which were regarded by the older writers as terminations of inflammation, and were classed with resolution and mortification. We may also examine the so-called termination by metastasis, as we will probably find no other place to take it up.

589. *Metastasis.*—A metastasis is a transferrence of the lesion from one part to another. It is rarely met with except in rheumatic inflammation, but the law upon which it is based is made use of in therapeutics. One of the most characteristic symptoms of a rheumatic inflammation is the rapidity with which it moves from one part to another. Thus a person suffering from rheumatism of one knee finds the symptoms of it abating, but that the other knee is becoming affected, and in a short time presents as severe symptoms as the first. The first part, however, is not wholly relieved, but is tender, somewhat red and swollen, and very weak. In *parotitis* we occasionally witness a metastasis of the inflammation from the parotid gland to the testicle, in a very similar manner to that of rheumatism.

590. The statement has been made, *that the animal body would not take cognizance of two local irritations at the same time,* and therefore, if a new inflammation arose, the old one would have to stop. This is true to a limited extent, and furnishes the basis for the employment of counter-irritation, or the relief of one irritation by establishing another. Some state the theory in this way: but one pain can be felt, and there can be but one determination of blood at the same time; therefore, if a new point of pain and determination is produced, the old ones must cease. The beneficial influence of a sinapism, blister, rubefacient frictions, etc., is, that they produce a greater irritation than that at the original point, and as the system regards the greater, the less ceases. To some extent this is undoubtedly true; at least experience proves that counter-irritation, to be effectual, must be greater than the

irritation for which it is used. Still, I think the influence of these agencies in stimulating the circulation of blood, and thus relieving the stasis of blood in the affected structure, plays an important part.

591. *Suppuration.*—Suppuration is a very frequent result of inflammation, and in some instances might be legitimately regarded as its termination, for it is instituted for the removal of the exudation and dead tissue. It is well to look at this process as it occurs on a free surface and within the tissues, as we will be enabled to get a much better idea of its nature.

592. Suppuration occurring upon a free surface takes place in the exudation alone. This exudation is of lymph, more or less plastic; and of this pus is formed, and the quality of pus, like that of tissue, will depend upon the quality of this lymph. Just so long as the vessels throw out this plastic material, suppuration continues; when it ceases, suppuration is at an end. We have seen that in inflammation of mucous membranes the exudation at first took the form of mucus, and it will continue in this form unless it progresses so far as to impair the vitality of the secreting tissue and the plasticity of the exudation. It is then that we observe the change from mucus to pus, and by it we are enabled to determine the condition of the structure pretty accurately. An inflammation of a serous membrane, when in moderate degree, causes an exudation of a slightly albuminoid serum, very closely resembling the natural secretion of the part. We witness this very frequently in inflammations of the joints, though not so often in the cavities of the body. If the inflammation is of a still higher grade, plastic lymph is thrown out, which may become organized, forming *false membranes* and adhesions; but if the vitality of the tissue and exudation is impaired, then the exudation is transformed into pus.

593. Suppuration occurs in a part when the exudation is of such low organization that it can not form tissue, or more frequently when, from the injury or the inflammation, the vitality of the tissues of the part is so reduced that it can not remain a

portion of the living body. Suppuration is really death, as much as mortification; but it is that slow molecular death that can be controlled by the vital processes for the removal of a part, without endangering the integrity of the adjacent structures.

594. If we examine this termination of the inflammatory process, we will find that in the majority of cases it is associated with resolution. Resolution commences from the circumference, and gradually restores the capillary circulation and removes the exudation. It progresses in this way until it reaches tissue that has so far lost its vitality that it can not remain a part of the body. It has lost more than this, for it no longer has the power of cell-production, and can not be reproduced. It is in this tissue that suppuration commences, and its end is its complete destruction in that orderly manner that will not injure adjacent textures, nor disturb the general health by its influence on the blood.

595. *Pus.*—We will obtain a better idea of the suppurative process by examining the material formed by it. Pus is an albuminoid or protein fluid of *low organization*, but still organized, and necessarily under the influence of the formative force. It is this organization that gives it that bland and innocuous character so different from animal matters that are undergoing putrefactive decomposition. We might say further that it is bland and innocuous just in proportion to its organization, and as it loses this, it assumes more and more the characteristics of putrescence.

596. Pus is composed of an albuminoid fluid, *liquor puris*, and *pus cells* and *pus granules* which are contained in it. The *liquor puris* varies in specific gravity, and is composed of water, holding in solution albumen, chloride of sodium, phosphates of lime and magnesia, and sulphate of lime. The *pus cells* or globules, are spherical bodies, about the two-thousandth to the three-thousandth of an inch in diameter; they have a very delicate cell-wall, which is rendered distinct by the addition of water, and are invariably nucleated. Pus granules have been regarded by some as nuclei for the formation of new cells, by others as the debris of broken-down cells.

597. The origin of pus globules is very interesting, as these bodies form the vital part of the fluid, and such organization as it has is dependent upon them. We have heretofore seen, when examining cell growth, that there is no new generation of cells, but that there must always be a parentage. Now as pus cells do not exist in the healthy body, it is evident that they do not have a parentage of kind, and if not formed *de novo*, we must trace their parentage to the formative cells of the body. Pus cells are with difficulty distinguished from mucous cells, which have their origin from epithelial cells and from the colorless blood corpuscles. There is no doubt but that they are furnished in free surfaces by the epithelial cells, and within the tissues by the cells of connective tissue.

598. As evidence of this analogy to normal cell types, and to fix their parentage, I will make a quotation from Virchow and Dr. Chambers. Virchow remarks :—

"With regard to pus, I need only remind you that we have been occupied during several lectures in discussing the question of the possibility of diagnosing between pyæmia and leucocytosis, and that we have recognized in the co'orless corpuscles of the blood bodies so perfectly analogous to pus corpuscles that some have thought they saw pus when they had colorless blood-corpuscles before them, while Addison and Zimmerman, on the contrary, imagined they had found colorless blood-corpuscles when they really were looking upon pus Both have a like type of formation. It may, therefore, be said that pus has a *hæmatoid* form ; nay, the old doctrine may be revived afresh, namely, that pus is the blood of pathology. But if one would seek a distinction—if one would be able to say in individual cases what is pus and what blood corpuscles, there is no other criterion than to determine whether the cell arose at a spot where a colorless blood-corpuscle might be expected to arise, or at one where it ought not to be produced."

599. Dr. Chambers, in his lecture on mucus and pus, after describing the microscopic researches made in this direction, says :

"These observations seem to show that the pus or mucus-

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the older or more permanent organizations, it is only to that extent which will replace worn out tissue, or add to it gradually as increased power may be demanded.

602. Regarding the formation of pus as a vital process for the removal of dead material, presents the process in an entirely different light from the older views, in which it was looked upon as a decomposition very similiar to the breaking down of animal matter when wholly deprived of life. For if it is a vital process, it is so by deriving vitality from the adjacent tissues, so that pus-formation will depend almost wholly upon the condition of these and the state of the blood.

603. Pus is described as healthy or *laudable*, when it is of a creamy consistence, contains a large number of pus globules, has but a faint odor, and is bland and unirritating. It is termed *sanious* or *serous* when it is thin and of a reddish or yellowish color; it is frequently *ichorous*, irritating parts that it comes in contact with. This is a product of unhealthy inflammation; that is, the tissues are enfeebled and a process of decomposition or putrescence is allowed to progress with the pus-formation, and sometimes exceeds it. At times the pus is in combination with considerable lymph, which has become partly organized, and it is then termed *fibrinous ;* when this occurs the inflammatory action is very high.

604. *Scrofulous* pus is that variety in which an inorganizable albumen is mixed with the true pus; it is found in scrofulous inflammations, cold abscesses, tuberculous diseases, and all cases where an albumen incapable of organization is effused. Gross remarks: "That when it stands a little time it separates in two parts, of which one is thick, straw-colored, and inodorous; the other, which rests upon the surface, is oily in appearance, thin, ropy, and mixed with small, opaque, curdy flakes." We have lastly to notice a very frequent discharge from mucous membranes, which is correctly designated as muco-pus, being a combination of the two secretions, which, however, vary in their proportions in different cases.

605. Suppuration in tissue is supposed to commence in the exudation, and as that becomes transformed, it then extends to the substance of the tissue itself. In a large majority of cases terminating in suppuration, the vitality of the part is impaired by the inflammatory process rather than by the original cause. And if we examine these cases carefully, we will find that the vitality of both exudation and tissue depends upon the adjacent circulation of blood. When there is still some circulation through the part, as heretofore described, suppuration does not occur, but when the capillary circulation is entirely arrested, then the exudation first, and the tissue next, are changed into pus.

606. The process of *ulceration* is not dependent upon pus-formation as has generally been supposed. It is true that from an open suppurating surface there may be a gradual loss of vitality from drainage of plastic lymph to supply the material for pus-formation, and the tissues may be exhausted in this way, but it does not go on to loss of structure. In ulceration the pus is rarely laudable until the extension of the ulcer ceases; while it is progressing there is a decomposition of tissue, which gives the pus an ichorous and corroding character. And just so soon as a normal suppuration can be established, this erosion of tissues is at an end.

607. Pus has not only an organization within itself, but under certain circumstances it is susceptible of assuming other forms. We have marked examples of this in certain skin diseases, in which the pus thrown off is arranged to form a membrane or scale, covering and protecting the suppurating surface. I think it probable that an epithelial organization of low type, bearing a very close relationship to pus, is developed in all the more chronic affections of the skin. And I am inclined to believe that in some a true purulent formation goes on at the same time with the formation of epithelial cells, and that what we know as a skin disease is dependent upon this changed epithelial development.

608. *Restoration of a Part after Suppuration.*—We have already described at some length (225) how the breach of continuity oc-

casioned by the breaking down of a part by suppuration is repaired. We saw, in the same connection, that the original tissue was never reproduced, but in its stead a low fibrous organization. The process is briefly as follows: Resolution commencing at the circumference, progresses to the point where the vitality of the tissues is permanently impaired, up to which part a free circulation is re-established. To protect the living from the dead part plastic lymph is thrown out, and organized into a membrane, the *pyogenic membrane.* As soon as the impaired tissues are converted into pus, and this discharged, restoration commences from this membrane by continued effusions of lymph which is partly organized, forming the granulations we notice, and partly transformed into pus. For a full description of this the reader is referred to (224) *et seq.*

609. *Adhesion.*—Adhesion is the result the surgeon desires, and he will never be dissatisfied with the inflammatory process that unites his wounds. In the practice of medicine, however, it is different, for it is very rarely that there are solutions of continuity to unite, but on the contrary, the adhesions occur and bind together parts that should be free. As an instance of this result I may name pericarditis, in which plastic lymph being thrown out upon the free surfaces of the membrane, is organized, and unites the reflected to the visceral pericardium. In pleurisy we occasionally witness the same result; the exudation being plastic is organized, and forms adhesions between the pleura-pulmonalis and pleura-costalis. And in peritonitis we not unfrequently see the same result, forming fibrinous adhesions binding together the viscera, and uniting these to the walls of the abdomen.

610. Occasionally lymph is organized upon the free surfaces of a mucous membrane, and though not forming an adhesion, it impairs the function. The most prominent instance of this we have is in pseudo-membranous croup, in which the false membrane organized in the larynx so obstructs the passage of air as to cause death. The casts of uriniferous tubes seen in some cases of nephritis and albuminuria, is another example of organized effusion.

611. *Induration.*—Induration is that condition in which the effused lymph becomes organized, instead of being absorbed after the capillary circulation is re-established. The part is larger and firmer, and to the extent that the adventitious material compresses the natural tissues or interferes with their free movement, the function of the part is impaired. We can not regard this as a degeneration of tissue, for it still continues to reproduce itself in its original position. But it is simply an additional fibrous element added to the connective tissue.

612. We have many examples of this when it gives but slight annoyance; as an induration of the skin, rendering it stiff and harsh, and sometimes more susceptible of irritation; induration of the cellular tissues causing stiffness and a feeling of tightness when of the superficial fascia; impeded muscular movement when in the course of the muscles, and stiff joints when in the neighborhood of an articulation. It is sometimes a serious matter when it occurs in internal organs: as in some cases of chronic pneumonia, when it effaces a majority of the air-cells in a considerable portion of lung, or in that peculiar condition of the liver known as the *hob-nail* liver, when it effaces the biliary secreting apparatus.

613 *Is Inflammation a Disease?*—This question is not unfrequently asked, as some have taught "that inflammation is not a disease, but rather a physiological process, being the best action that nature could establish under the circumstances, and leading to the restoration of the part." As we have already seen, an inflammation is always produced by an irritation which impairs the vitality of the tissues: and it is claimed that this action is restorative, or at least during the process the part regains its normal condition, or the body is relieved from it.

614. The following examples are adduced to sustain this view: "A boy runs a thorn in his foot; following this is a development of inflammation, which causes an exudation of lymph around the foreign body, which breaking down some portion of tissue loosens it, and finally, by pressing upon it from below, causes its extrusion. Now, they say the inflammatory process loosened the thorn,

causing its expulsion, and after this, by the exudation of plastic lymph, causing the healing of the wound. Going still further, they claim that all reparative action in surgical injuries is due to inflammatory action. There is a solution of continuity which is to be closed up; nature establishes the inflammatory process, and from *this* is the exudation of plastic lymph and the closure of the wound.

615. The conclusions drawn from this reasoning are as follows: Inflammation being nature's method for the repair of injuries and restoration of parts, it is a necessary evil, if evil it be; therefore let it alone. Do not try to reduce it (the common antiphlogistic means being referred to), but let it progress until it accomplishes its purpose. It is admitted that it may be well to control it to prevent harm, as it sometimes rises too high.

616. If we examine inflammation as it affects internal parts, the question will be seen in another light. A man to-day has a sound pair of lungs; to-night he is exposed to rain and catches cold; to-morrow he feels badly, and in two or three days he has a marked inflammation of the lungs. If we trace the progress of the disease, we will find that on the third day from this there is capillary engorgement; by the fifth day so much exudation that the majority of the air-cells are effaced; and continuing beyond this the tissues lose their vitality, and more or less of the lung is lost by suppuration. If we would examine the lungs day by day, we would find that with no structural lesion at first, this increased until it eventuated in complete destruction of tissue. Experience proves that the sooner this inflammation is arrested the better it is for the lungs; that if it is stopped the first day no perceptible lesion remains; that resolution is better the third day than afterward, but that resolution at any time is better than any other result. What is the condition of the part after resolution? Has it been changed, or its vitality renewed? No; but on the contrary it is the same tissue to its ultimate cell-formation; and there has not been a shadow of repair, but, on the contrary, it has been enfeebled by the arrest of its nutrition during this period.

617. If we examine *surgical* inflammation we will find it the

same. The inflammatory process is not necessary to the closure of a wound or the repair of tissue; and the general health and vitality of the part being good, the less inflammation there is the speedier and better is the repair. Whatever theory surgeons may have, the majority practice upon these facts. Local applications and internal treatment are directed to the same end. If, however, a part is so feeble that an inflammatory process *can not* be established, then it is too feeble for nature's process of repair, and means are employed to get a better circulation, better innervation, and a better vitality of the part itself.

618. I think we may safely assert that an inflammatory process is never necessary, and that where it is a good it is never an unmixed one. Grant that it is nature's method of restoration, it is only so in that state of artificial civilization in which we live. We find that nature heals wounds and repairs textures in animals without it—in the Indian and other barbarous people without it—so that at last it is only an evidence of our imperfection, and as we approach that normal condition of health which is our right, the inflammatory process disappears.

619. In reviewing the entire history of the inflammatory process, I think we must conclude: 1st. That its cause is always such as impairs the vitality of the tissues, and partially or wholly prevents normal nutrition and waste. 2d. That every step of the inflammatory process is an evidence of weakness, as in the arrested capillary circulation, the exudation, and the increased heat and pain. 3d. That the continuance of the inflammatory process increases the debility of tissue, and that each successive step leads nearer and nearer to its complete death. If such conclusions as these can be truly drawn, it will give an entirely different basis for therapeutics, and the older methods of treatment must become obsolete.

620. With every inflammation we have more or less constitutional disturbance, and, as a rule, this is in proportion to extent of structure involved, to the intensity of the inflammatory action, and the importance of the organ or part involved. If the part is small and unimportant, the constitutional disturbance will be but small, as in circumscribed inflammation of cellular tissue. If small, yet important, it will be much more marked, as in inflammation of the eye, the larynx, a testicle, a tonsil, the prostate gland, the urethra, etc. When large portions of important organs are involved, as the lungs, or the brain, the symptomatic fever is the most prominent part of the disease.

621. *Symptomatic Fever.*—The fever and the inflammation are so closely related to one another that we can not disassociate them. As is the intensity of the inflammatory action, so is the intensity of the fever; and as is the intensity of the fever, so is the inflammatory action. If, for instance, we have an idiopathic fever, and an inflammation springs up in its progress, we expect all the febrile symptoms to be increased, the disease to become less amenable to remedies, and the danger to life increased. And if, during the progress of an inflammation, from any cause, we have an increase of the febrile symptoms, we expect that the inflammatory symptoms will be more marked, and there will be greater danger to the life of the part.

622. Again: if in inflammation we can control the fever, in the same degree we control the inflammatory action; and if we can stop the fever, we will probably stop the inflammation. So, also, if an inflammation spring up during a fever, and we have local or internal remedies that will control and arrest it, we will find the fever less intense and more easily managed. It is worth our while, therefore, to study the symptomatic fever, and to separate it into its component parts, and see the bearing of each upon the inflammatory process. This we will do after briefly noticing the *symptoms.*

623. *Symptoms.*—Symptomatic fever presents the same symptoms as the idiopathic, less the forming stage, and in some cases it even has this. If the cause is cold, deranging the circulation, or a blood poison introduced from without, or a blood poison generated within, either in wrong of retrograde metamorphosis or arrest of secretion, we may have a forming stage of several days. It presents the usual symptoms—there is gradual impairment of function, loss of appetite, debility, with evidence of local disease, and more or less pain. Then follows a chill, quite as well marked as in idiopathic fevers, and then febrile re-action, in which all the symptoms of the inflammation are developed.

624. *Frequency of Pulse.*—Among the prominent symptoms of fever is acceleration of the pulse, the blood being distributed more rapidly through the body. If we think of it, this very closely resembles the condition of the circulation in the inflamed part, to which we have an increased circulation, and in a portion of which the movement of the blood is rapid. The movement of the blood is under the control of the sympathetic nervous system, not only in the body at large, but in each individual part. There is excitement of these nerves locally when we have determination of blood to a part; there is excitement of this nervous system in the whole, when we have the general increased rapidity of the circulation.

625. Just in proportion to the frequency and the change in the pulse is the intensity of the local disease. We can readily see how this is if we think for a moment, and to the local excitation add the general excitement. And so we say, that just in proportion as the general circulation is brought back to the normal standard, just in that proportion the part will be relieved. It is not only frequency that we look at—change is sometimes quite as important. The pulse *full, hard, sharp, oppressed, small, irregular, feeble*, have all to be estimated, and the remedies that rectify these wrongs, and give a normal circulation employed.

626. *Increase of Temperature.*—Increased heat was one of the prominent symptoms of the inflammation, and it is also one of the pronounced symptoms of the symptomatic fever, and one that

we closely estimate in every form of disease. We may put the proposition in the usual form—as is the temperature so is the performance of every function of the body ; as is the temperature so is the intensity of, and danger from, the inflammation.

627. Increase of temperature is associated with increased frequency of pulse, as we have already seen. As the temperature is increased, we have disturbance of the nervous system, arrest of secretion and excretion, impairment of digestion, impairment of the blood, and impairment of nutrition. A temperature of 98° is a condition of healthy life in the body at large and in each part. A higher temperature, therefore, looks toward death, and may influence the death of the inflamed part.

628. *Arrest of Excretion.*—Deficient excretion from skin, kidneys and bowels, is among the prominent symptoms of fever. From this we have material retained in the blood that should be removed, and which evidently serves as a cause of irritation, both general and local. It is a common source of blood poisoning. If in inflammation excretion is markedly arrested, we find all the symptoms increased : the irritation is greater, there is a more active circulation to the part, and the life of the part is impaired by the changed condition of the blood.

629. If excretion is restored, the inflammatory symptoms are lessened, and the part relieved, and this in so marked a manner that the relation between the two can not be mistaken. In a severe inflammation, a moist, active skin, free excretion from the kidneys, and regular movement of the bowels, are certain to be followed by an abatement of the inflammatory action. It is true that secretion can not be established until the pulse is reduced in frequency and becomes normal, and the temperature comes down to 100°; but even when these last are obtained, secretion may not commence. We have a better circulation and a better temperature, but there is still arrest of secretion, and the inflammation continues, and looks toward suppuration. Now we use means to establish secretion, and at once resolution commences.

630. We associate excretion with absorption of the effusion ; and when material has been thrown out into a part, and absorp-

tion does not go on as it should, we always think of accomplishing it by establishing free excretion. These remedies undoubtedly favor retrograde matamorphosis, as they also stimulate the excretory apparatus to take hold of the material, and carry it out of the body; and, as is commonly believed, they stimulate absorption of any adventitious material outside the blood-vessels. Thus in chronic inflammations especially, they are among the prominent means of cure.

631. *Disturbance of the Nervous System.*—Wrongs of innervation are common in symptomatic fever, and always intensify the inflammatory action. Whether it is excitation or depression, or any of the many changes we note in innervation, the effect will be the same. We might note the influence of the malarial poison that gives periodicity, which, though influencing the blood, also acts through the nervous system. Let this be marked and continued, and the inflammatory process is intensified, and may destroy life. Arrest the periodicity with quinine, and the inflammation is modified or arrested.

632. Given, the flushed face, bright eyes, contracted pupils, with restlessness and sleeplessness, and gelseminum becomes a direct remedy to imflammatory action. But it is not necessary to give examples here, as we will get them when we study the action of remedies.

633. *Changes in the Blood.*—We note that any change from the normal condition of the blood uniformly influences the progress of an inflammation. "The blood is the life of the man," says the inspired writer, and we repeat that the blood is the life of the part. Given a case of inflammation, and the termination may depend upon the condition of the blood. If the blood is good, the part will live, and the termination will be in resolution; if the blood is changed and bad, the part dies.

634. When we study exudation, we find the material may be *euplastic*, *cacoplastic*, or *aplastic*, or a material that has life and can be organized or readily absorbed; a material that is low in life, that can not be organized, and is difficult of absorption; and a material that can retain its condition but a limited time, must

break down and will carry with it the tissue, and can not be absorbed. These are all drawn from the blood, and we say, "as is the blood, so is the deposit"—from a good blood a good deposit; from imperfectly organized blood this imperfect material.

635. We have already studied "dyscrasias," or bad blood, and we found that there was something real in the common belief, and that there might be unpleasant material in the blood that only waited for an irritation to be thrown out. In inflammation we have such an irritation, and with the constitutional disturbance we have the very conditions necessary to increase the amount of such material. Thrown out into an inflamed part, we have the material that will cause local death. Thus we distinguish certain inflammations as having this wrong. We have "white swelling," some diseases of bone, hip-joint disease, iliac and psoas abscesses, etc., and we also have inflammation of the lungs and other structures in which the condition is quite as clearly marked.

636. Special poisons, as *erysipelas*, *diphtheria*, and some hospital infections, exert a morbid influence, and give a peculiar character to an inflammation. We recognize their influence in intensifying all the phenomena, as well as impairing the life, and we endeavor to keep our patients free from them, and use every means to overcome them in the early stage of the disease. The rheumatic wrong of the blood, though less severe, may be noted as calling for special remedies.

637. Simple *alkalinity* or *acidity* of the blood exerts quite as marked an influence upon the inflammation as it does in fever. Given the *deep-red* tongue, and we are sure that the inflammation is not doing well, and can not do well, and we give the acid with the same certainty that we would if it was a case of continued fever. Or if the tongue is broad and *pallid*, we expect to get relief for the inflamed part by giving a salt of soda, as we expect to get it in fever.

638. *Typhoid symptoms* are not uncommon in the graver cases of inflammation, and we recognize the impairment of the life of the inflamed part, and its danger, as we recognize the general danger in a fever with these symptoms. A typhoid blood means

death, and needs to be looked after early. What are typhoid symptoms? If the mouth is moist, the tongue is *dirty:* if the tongue is dry, the coatings have a tinge of *brown*, gradually growing deeper as the typhoid condition increases.

639. *Impairment of digestion* and wrongs of the digestive apparatus are common to inflammations and fevers, and exert a like unpleasant influence. The sick must have food, if they are to retain strength to resist the processes of disease; and thus it is our business to see that the digestive apparatus is maintained in good condition, and that the patient has food.

640. *Treatment.*—In our consideration of the principles which should form the basis of a rational practice, it will be necessary to examine each stage of the disease, and the remedies applicable to its arrest, or that will conduct it to the most favorable termination with least change of structure. We take the ground that its *arrest* is always the best result, and that *resolution* at any period is far preferable to any other result.

641. I think the principle is just as applicable to surgical inflammation. Every *good* surgeon will tell you, that if he can secure entire immobility of the part, so that there will be no irritation—consequently no inflammation—the process of repair will be both speedy and perfect. I have noticed with surprise the almost entire subsidence of inflammation after the removal of sequestra and carious bone, and the rapid healing of the part with an entire absence of the four symptoms, heat, pain, redness, and swelling. Of course we would not expect such perfect results when the disease originated in scrofulous deposits, but when it was the result of an injury in healthy persons.

642. The modern treatment for wounds is based upon this view of inflammation. The removal of all causes of irritation, carefully adapting and supporting the parts, and the use of a water-dressing to prevent inflammatory action, or by Dr. Richardson's method, such applications as will perfectly shield the part from the action of air and prevent irritation. Union by first intention occurs only when by these means the inflammatory process is prevented.

643. Another method of treating superficial inflammations, is based upon the idea of feebleness of the part affected. It consists in the application of such stimulants as will give the part power to restore the capillary circulation. The application of iodine, tincture of muriate of iron, etc., is upon the same principle. Painting a part with fresh collodion, until a heavy deposit is made, is an excellent means for arresting the inflammatory process. It acts in three ways: The evaporation removes the excess of heat, it gives direct stimulation to the part, and by its contraction it gives the part a very equal support.

644. There are other local means in general use that look to the same result, though they are frequently employed without any well-defined idea of the correspondence between the action of the medicine and the pathology of the disease. Thus stimulant liniments and embrocations are successful in slight inflammations, because they so stimulate the part as to restore its circulation. Narcotic and sedative applications are useful, and arrest inflammatory action when of a very high grade, and in consequence of this extension to adjacent structures. The direct application of cold occasionally arrests the inflammatory action, by causing contraction of the dilated capillaries and thus overcoming the stasis of blood. Cold by evaporation, as in the use of Richardson's local anæsthesia, acts in the same manner. Heat and moisture, as the use of hot fomentations, sometimes accomplishes the same object by favoring the restoration of the capillary circulation.

645. The judicious selection of one of these means will depend upon the appreciation of the exact condition of the affected part, and he will be most successful who is most careful in his diagnosis.

646. The principle upon which the general treatment is founded is, that the inflammatory process is always rendered more destructive by a rapid or unequal circulation, by arrest of secretion and by perversion of the blood. These are the three important points in a successful general treatment, and when we have accomplished these objects, there is but one more important point, and that is to increase the quantity and quality of the blood, and thus favor repair.

647. When there is brisk febrile action, the special sedatives should be employed in the small doses heretofore named, and their influence may be aided by the use of the general bath and hot foot-bath. If there is an irregular circulation of the blood, this must be corrected by such means as will call it to those parts where it is deficient. In regard to the use of the special sedatives, I hold that in inflammation, as well as in fever, they lessen the frequency of the pulse by giving more power to the heart and arteries—that they are really arterial stimulants, rather than sedatives, as the word is generally employed and understood. This action is undoubtedly through the medium of the sympathetic system of nerves; and as the same system of nerves controls the capillary circulation, we see no reason why this stimulant influence should not be extended to those vessels. I am satisfied that it is so extended, and that the inflamed part feels its influence in an increased vital power, especially manifested in its circulation.

648. So marked is this action, that I have many times seen the arrest of inflammatory action under the use of veratrum and aconite alone. I do not trust alone to my own observation, but I find in the medical press reports from a large number of observers, which go to prove this view. No one seems to believe that these remedies act upon any known law, or that there is any regularity in their action, and hence the reports are purely empirical. One observer treats all cases of pneumonia with veratrum, and is ready to vouch for its specific action in scores of cases. Another uses the same remedy in erysipelas; still another in croup, or bronchitis, until we can group enough together to take the entire range of inflammatory diseases.

649. The second indication of cure, *to restore the secretions*, follows the sedatives in a natural order. There must be a regular circulation before secretion can be established; but in order that the inflamed part recover speedily, it is necessary that the blood be freed from retained excretion. The presence of such effete matters in the blood always increases the inflammatory processes, as it impairs the vitality of all tissues, and would be especially *marked* when a part was already deprived, to a certain extent, of

its power of resistance. The act of excretion is also necessary to a free an equal circulation of the blood—a very important point in this case. But whether we are able to give a rational explanation or not, the empirical fact that these are among the most powerful means for the arrest of an inflammation, and that restoration of the excretions always attends the process of resolution, is as well known as any fact in practical medicine, and is continually acted upon.

650. *Perversion* of the blood is one of the most serious concomitants of an inflammation, as the local disease is inclined to assume a similar action to that going on in the blood. Thus we have a class of inflammatory diseases known as *typhoid*, in which the low grade of inflammation is dependent upon the condition of the blood; and we observe that as this typhoid condition of the blood increases, the inflammation assumes a lower and lower grade, until finally the parts seem to have no vitality remaining. We may observe this better in the fever attending surgical operations. While there is no lesion of the blood, the fever being of a sthenic character, a laudable pus is produced, and the process of repair goes on; but if the fever assumes an adynamic form, with dark tongue and sordes, we find the pus becoming more and more sanious, and the process of repair is entirely arrested; and in the extreme stage the tissues involved seem to break down in a condition of putrescence.

651. Erysipelas furnishes us another marked example in which impairment of the blood works destruction of tissue. Even when the blood is impaired with the malarial poison the inflammatory process is influenced by it, and repair of injuries is slow and sometimes wholly arrested. As a general rule the inflammatory process is very severe in cases of the eruptive fevers, and from an observation of two cases in which small-pox followed surgical operations, I am satisfied that not only is the process of repair arrested, but the patient's life is endangered by the local influence of this animal poison.

652. Treatment directed to this condition is of marked importance. One of the most marked instances we have is the influ-

ence of quinia when the inflammation is associated with a malarial influence. In very many cases its administration, in sufficient quantity to arrest the periodic fever, is followed by a rapid resolution of the inflammation. The administration of tincture of muriate of iron in erysipelas is another marked instance of the influence of remedies that antagonize specific poisons. The typhoid lesion affords a broad field for the use of these remedies, and many times the preservation of a part, or of the life of the individual, will depend upon how we use them. It is not necessary here to discuss this subject, as we have already considered it at some length, but I want to draw attention to two points—in the one case, where there is the broad, white, or yellow and pasty tongue, the importance of a salt of soda; in the other, when the tongue is red or coated brown, the importance of the mineral acids—I prefer the muriatic. This subject has such importance that I would advise the reader to turn back and re-read the paragraphs on the salts of the blood, and the influence of morbid material within it.

653. In addition to the ordinary wrongs of the blood grouped under the term "typhoid," we have certain special ones that may be studied with advantage. Thus every inflammation may be erysipeloid, as it may be diphtheritic, or may have that increased virulence that leads to deliquescence or sloughing, without apparent cause. There is something peculiar in the symptoms in these cases that should cause us to recognize the unpleasant character of the disease. The pain is burning or scalding; the color is very vivid; the surface is glistening; the heat is pungent; and the epidermis is inclined to separate in blisters. The remedies we study in this connection are the rhus, veratrum, tincture of muriate of iron, baptisia, phytolacca, and possibly apis and belladonna. As local applications we have iron, veratrum, salicylic acid, sulphurous acid, and permanganate of potash.

654. Remedies that place and keep the digestive organs in good condition are of great importance in the treatment of inflammation. We do not have to associate this with the repair of a part alone, for it is just as essential to the preservation of the part by

the establishment of resolution. A sufficient supply of nutritious and easily digested food, and the power to appropriate it, is as important in inflammation as it is in fever; and sometimes it would seem as if it took precedence of all other means. I have seen as marked an influence from a pint of beef-tea, in cases where a part was likely to lose its vitality, as I have ever seen from any medicine.

655. We have been, thus far, studying the treatment of inflammation with reference to resolution, and we have now to look at its other termination—mortification. We have some remedies that exert an influence in opposition to this termination. They act principally by stimulating the part; but they also possess antiseptic properties, which doubtless have some influence. The sulphate of zinc is the most powerful of these, and will sometimes arrest the tendency to mortification; yeast and charcoal act in the same way, but are much feebler.

656. When we are satisfied that resolution can not be effected, we endeavor to terminate the inflammation by suppuration. As a general rule, the sooner the suppurative process is established the less tissue will be lost by it, as it seems to free the outer tissue of some oppression which has opposed resolution. Of course, the part that is broken down by suppuration is as entirely lost as it would have been by mortification, and we desire to restrict the process as much as possible, at the same time that we favor its development when we know it is inevitable. While we favor the speedy development of suppuration by the use of emollient poultices and moist heat, the same means usually tend to restrict it to the smallest portion possible, because they favor capillary circulation. In other cases we limit the suppurative process by direct stimulation.

657. When pus is formed, the sooner it has a free escape the better it is for the adjacent tissues, as it relieves them from compression, and permits further relief by exudation. Though this is the general rule, it is claimed that there are some exceptions, as in cases of hip-joint disease, when the opening of the part to the influence of the air would prove more detrimental than the

presence of pus. This was the doctrine of Mr. Hilton, and he claimed further, that the purulent product would be eventually absorbed. In opposition to this, we have the modern experience in favor of free openings in suppurating inflammations of joints. I believe the propriety of this practice, which originated with Dr. Cooper, of San Francisco, is now generally admitted.

658. If we have suppuration, we are interested in having a laudable pus, as it is with this only that we can expect good repair. The common cause of vitiation of the pus, so far as the part is concerned, is the feebleness of the tissues that produce it. To remedy this, surgeons are in the habit of employing such agents as will break this imperfect tissue down, and stimulate the adjacent parts. Dilute nitric acid has been recommended for this purpose, and in some cases the stronger acid is used. Sulphate of zinc has been much employed, and is esteemed one of the most valuable agents, but I prefer the sesquicarbonate of potash. In other cases we do not use means to break down tissue, but simply to stimulate it. The permanganate of potash is an excellent agent in this case; a weak solution of sulphate or chloride of zinc answers well, as does a solution of sesquicarbonate of potash.

659. The second cause of vitiation of the pus is to be traced to a want of proper quantity and quality of the blood. Not unfrequently we find that by the use of bitter tonics and iron, improving the appetite and digestion, and the supply of a nutritious diet, the pus becomes laudable and the process of repair is re-established.

660. In the repair of a part we find frequent need of treatment. As a general rule it may be stated that the repair of a part progresses in the ratio that it has rest, warmth, and protection from external influences. Thus it is held by some that the coagulated blood furnishes the best dressing, as giving warmth, and protection. Dr. Richardson prepares a styptic colloid which thoroughly shields the part in the same manner. The water-dressing to an open part, when there is free suppuration, answers an excellent purpose. Very many times we will find that *rest* alone is wanted,

and this we endeavor to impress upon the patient. In other cases the repair proceeds slowly, or is arrested because of the feebleness of the tissues which furnish the germs for the new cell-growth. In this case we stimulate the part by direct applications, as when we order a solution of permanganate of potash. In other cases we find it better to destroy a portion of the new growth, and thus get a new base for repair.

661. In those cases in which we have reason to fear the organization of effused lymph, and the formation of adhesions, in addition to the means for the arrest of the inflammation, it becomes necessary to employ such as will lessen the plasticity of the blood. The principal of these are the alkaline diuretics, though the saline cathartics may also be employed. Occasionally the veratrum may be given to obtain its depressant effect, and this if followed by a solution of acetate of potash will usually answer the purpose.

662. The same means may be employed when there is a tendency to induration; and in addition to these the vegetable alteratives are frequently of much benefit, and should always be employed when an important part is likely to suffer from this result.

CHAPTER IX.

INNERVATION.

663. Lesions of the nervous system play a very important part in disease, and we rarely find a case in which they do not form a part, and must be estimated in the diagnosis. They also exert a more or less marked influence on those pathological changes we have already considered, and it is through the nervous system, to a considerable extent, that we are enabled to modify and change the various processes of life.

664. It is difficult to adopt such a classification in this case as will present the matter in a simple manner, without at the same time leading the student into error. For if we take the classification of Dr. Williams, and regard the functions of the nervous system as four, viz., *sensation*, *voluntary motion*, *involuntary motion*, and *sympathy*, we omit the various influences that follow the simple exercise of mind and volition which are not manifested in motion, as well as some of the important functions of the spinal cord and of the sympathetic system, which can not be included either in involuntary motion or sympathy.

665. I think, therefore, we will arrive at a more definite understanding of the subject if we group these lesions as they arise in the three parts of the nervous system—the *brain*, *spinal cord*, and *sympathetic ganglia*. As these three portions are associated in action, in health, so also do we find them in disease, so that it is always possible to locate a lesion in either one; but, as a general rule, it will not be difficult to locate the principal lesion in one or the other.

THE BRAIN.

666. The brain is the organ of the mind, and receiving impressions from all things associated with us in the world, gives us a conscious existence. If we study the comparative anatomy and physiology of the nervous system, we can not but see that the simple act of living is in nowise dependent upon a brain. Indeed, those lower orders which have no brain, have the *formative* power in much greater proportion, as well as greater tenacity to life. We conclude, therefore, that the brain adds nothing to man's power to live, regarding simply the formative act, though, from its relation to the entire body, it controls this to a certain extent. Certain portions of the brain, indeed, seem to lessen the formative power, so that their development in considerable degree becomes an element of weakness. This is especially marked in the cerebrum, which is the principal organ for the reception of impressions and of thought. The basilar portion of the brain may be regarded as an expansion of the spinal cord, with which it is intimately associated in action. This portion is doubtless the seat of volition, in which thought becomes active in the body through the nerves which radiate from it to all parts.

667. Simple thought without volition is the function of the superior; volition, or giving this thought birth in action, of the basilar. If we notice these developments in health we will learn an important lesson. The undue development of the superior portion always enfeebles the formative power, or what is sometimes termed vegetative life. While an active volition, in exercise of the basilar portion, on the contrary, gives increased formative power or vegetative life. It is hardly worth while to give examples in proof of this, as they are so numerous and common. It is very clearly manifested in school children; those whose studies are principally mental, or in thought without volition or action, invariably deteriorate in health, and in very many instances so lose the power to live as to occasion an early death. That child, however, that gives a considerable portion of thought an

external development, through the basilar portion of the brain and volition, will increase his vital powers.

668. There are no harder students than authors, yet they are long-lived, and generally enjoy good health, notwithstanding much confinement and sedentary occupation. The thought has birth in volition, and manifestation in writing. No class of persons are longer lived than teachers (this is proverbial about college professors), ministers, lawyers, physicians, those that work, and it is this out-birth of thought in action that gives the vitality.

669. The conclusions I draw from this are, that the upper portion of the brain or cerebrum is non-vital, while the lower portion, as it is associated with functional activity of all other parts, is vital. We have additional evidence of the truth of these propositions in disease. I think I am safe in saying that excitation of the superior is far more exhaustive than of the inferior. Physicians of experience dread that condition in which the delirium is *dreamy*, having no corresponding action; but regard that lightly in which the action corresponds to the thought. The one is the delirium of typhoid fever and analogous diseases, the other of sthenic affections.

670. The functions of the brain we wish to study are, of thought or reasoning, the emotions, of volition, and of sensation: to these may be added voluntary motion. It is not possible to do this subject justice in the brief space I have assigned it, neither will the student or general practitioner wish to occupy the necessary time with its study, as it embraces the entire history of mental lesions, which already has a literature that embraces volumes.

REASON.

671. Reason distinguishes man from animals, and being his highest attribute, its lesion, next to deprivation of life, is the most serious that can befall him. Like all other lesions, it may be measured by the common standard of *excess*, *defect*, and *perversion;* and if in this way we calmly analyze any case, and com-

pare the present condition of the patient with his condition in health, or, if this is not known, with the standard sound mind, there is little danger of our running into error.

672. *Excess* in the exercise of the reasoning power always leads to debility. At first it will be manifested in bodily weakness, and irregular functional action; but finally it will exhaust the formative power of the brain, and lead to softening, and then death, or permanent impairment of the function of the brain. We rarely see a simple excess in disease, either acute or chronic, local or sympathetic, as it is almost always associated with perversion. Occasionally, in the early stage of fever or inflammation, we find an excessive action—the patient thinks of everything, and pursues the train of thought and arrives at conclusions with great rapidity. This is a condition that works mischief in many ways, and should always be controlled as much as possible. Strict prohibition of such conversation as would lead to this activity, sponging the head, a stimulant foot-bath, a cooling purgative, with the means applicable to the disease he is suffering from, are usually sufficient.

673. I have had persons in business apply to me for this lesion. They could appreciate that the brain was extraordinarily active, and though the reasoning was perfect, yet from the fact that it was depressing the health, and at times beyond their control, they were led to fear permanent impairment of the health, or insanity. These cases are most common in large cities, and are met with principally in men engaged in business, especially at those seasons when trade is extra hazardous. Mental quietude, with *active physical exercise*, are the principal means we employ. If such a person can be interested in any out-door sport that he has strength for, a cure will result in a short time. A general tonic treatment is beneficial in so far as it improves the general health, and to this may be added the administration of the hypophosphites, or phosphureted oil, with cod-liver oil.

674. *Defect* in reasoning power is met with in very many acute diseases, and in most of those chronic affections in which the quantity and quality of the blood are impaired. Its bearing upon

the progress of the disease is not important, but it assumes great importance in medico-legal investigations, determining the acts of persons, when in this condition. The physician is placed in such position that he can most readily appreciate the lesion, and I hold it to be clearly his duty to prevent, so far as he may without exercise of any undue authority, such acts influencing others, as would not be done if the person had full use of his faculties. The disposal of property at such times by devise or will is a manifest error in our laws, as when the reasoning power is thus feeble, the person is not in a position to appreciate the bearings of various circumstances and influences that may surround him.

675. The bearing of this independence of the reasoning power upon the general health, especially upon the condition of the blood and nutrition, should be fully appreciated; and the evidence of the attending physician when called for in proving such will, should clearly state the testator's condition. When a will is *against* the dictates of natural affection, and contrary to the usual custom, and especially contrary to the habits of thought of the individual in health, the duty of the physician in the above regard becomes imperative. Such a will, in my opinion, should never be admitted to probate, as the common and statute law directing the descent of property is in equity and morals the results of the world's experience for centuries. I think, further, that in many instances it is the physician's duty to place the matter before the sick person in this light, especially if his opinion is asked, as is so frequently the case.

676. We are occasionally consulted by persons who have noticed this failure and desire advice with regard to means to prevent its further progress, and to regain the power they have lost. In a majority of cases it will be found to arise from great activity of thought without volition: we might say *inactive thought.* This is the case with the student, especially in literary colleges; in some cases with those who are termed *inventors*, but whose inventions do not take form; with business men whose thought far outruns the necessary course and sequence of business, and with professional men, when thought has no outbirth in action. The

common appreciation of this condition is expressed in the term "building castles in the air," though in this case it is not the transient gratification of man's ideal nature in a day-dream, to which the expression should be properly restricted.

677. In the treatment of such cases we take into consideration the two parts of the affection—the *physical* and the *mental.* Experience proves that those agencies which improve the processes of digestion and nutrition are of great advantage. We see, therefore, that the stomach is in condition to receive and appropriate a normal amount of food, and that the excretory organs are sufficiently active to remove the waste, which leads, as Dr. Chambers tersely expresses it, to a "renewal of life." The influence of phosphorus, iron, quinia, and cod-liver oil, upon the nutrition of the brain, is occasionally very important. Associated with this is out-door exercise, change of scene, and those social influences that call into action the dormant faculties of the brain. The strictly psychical treatment has reference to the arrest of the overactivity of certain functions of the mind, and to the establishment of a well regulated activity of such other functions that may have outbirth in bodily action. In a majority of cases, if the pathology of the mental disease is clearly explained to the patient, his *volition* will be sufficient to cause him to avoid those circumstances which would lead to the overexercise of those mental functions which have proven exhaustive, and at the same time he will be led to seek such recreation and business as will call into play other functions of the mind. The most important element of the mental treatment is, to have all mental action associated with physical action, for in this is increased activity of the purely vegetative functions, as well as a strengthening of the will and a corresponding command over the action of the mind.

678. The education of idiots, which has engaged the attention of some charitable persons during the last quarter of a century, and with a good degree of success, furnishes some very important facts in psychical pathology and therapeutics, and persons especially interested in this subject will do well to get the published reports. The evidence is conclusive that the reasoning

power is subject to the common law of development by exercise.

679. *Perversion* of the reasoning power gives us *insanity* in its varied forms as well as delirium. It may be confined to certain faculties of the mind, giving the milder form designated as *monomania*, or it may involve all the faculties to a greater or less extent, and is then designated as *mania*. Insanity is not only a perversion of the reason, but it is also a loss of volition, or the power of setting up and conducting those processes of the mind which we term reason.

680. We are unable to say what the real pathological condition is in some of these cases. In some, *post-mortem* examination reveals a perceptible physical lesion of the brain, while in others we can detect no change to account for the morbid manifestations during life. In insanity, we have reason to believe, that it is primarily psychical, and that the lesion of structure is the result, while in delirium, the lesion of structure or condition is the cause of the perversion.

681 I do not feel myself capable, nor is this a suitable place to examine the pathology of insanity. The subject is so broad, involving the entire principles of mental action, that it can only be studied to advantage by those who are willing to give considerable time and attention to it. We will, therefore, confine ourselves to the examination of those acute cases in which the perversion takes the form of delirium and is the result of a physical lesion.

682. We might recognize four forms of such physical lesion—where there is irritation and determination of blood; where there is an enfeebled circulation and nutrition; where there is change in the constitution of the blood; and where there is perverted nutrition.

683. *Irritation and determination of blood to the brain* gives rise to the acute delirium that is met with in the more active forms of fever and inflammation. The evidences of this determination are found in the increased heat of the head, flushed face, bright eyes, and contracted pupils, and greater susceptibility to impressions. The mind is active in all its functions, though both reason

and volition are perverted. In this case we find that the delirium may be controlled by the use of stimulant foot-baths and other means of revulsion, by cold affusion or evaporating lotions to the head, and the use of saline cathartics and diuretics. The special sedatives exert a marked influence on this condition, and we have one special agent, gelseminum, which may be employed with great advantage.

684. If such irritation continues, it may result in inflammation, during the first stage of which delirium is also present; but if it does not, and continues on, the delirium will result in debility and such enfeebled innervation that many functions will suffer. Or, in other cases, such great excitation will result as to prevent sleep or rest, and the vitality of the patient will be exhausted in this fruitless activity. Where it terminates in nervous debility, such remedies as favor nutrition of nerve structure are of great importance. Small doses of opium with quinia, the use of strychnia, phosphorus, and occasionally of alcoholic and vegetable stimulants, are of great importance. In the other case, rest and sleep are imperative, and if not obtained, a fatal result is certain. I like the action of a combination of opium, camphor, and quinia, in this case, the first being in small proportion. The hypodermic use of a solution of morphia and strychnia also answers a good purpose, as does the use of chloroform either as an inhalation or by mouth.

685. *Delirium tremens* arises from this and the second condition also. In the first case, the derangement of mind is manifested while the person is drinking and under the exciting influence of alcohol. In the second, it commences after he has ceased drinking, frequently when the stomach will tolerate no more—as it is popularly expressed, "when he is *sobering* up." In the first instance there is evidence of vascular excitement of the brain, and the delirium tremens is an *active* condition. In the second case there is as marked evidence of exhaustion and feeble circulation in the brain, and the delirium tremens is a *passive* condition.

686. The rational treatment of delirium tremens must be based upon this distinction, as in many respects it is directly antago-

nistic in the two cases. In the first case, the use of the special sedatives, in doses sufficiently large to obtain their *depressant* effect, is almost specific. I have been in the habit of using the veratrum and gelseminum in combination, giving from five to ten drops of the first, to ten to thirty drops of the second, every half hour or hour, until the pulse was reduced to fifty per minute. As soon at this effect is produced the excitement abates, and sleep may be produced by the usual doses of chloral. Others use large doses of tincture of digitalis, sometimes to the extent of half an ounce at each dose, and report the treatment as very successful. In the second case, I direct stimulants and fluid food. Tinct. of capsicum, or beef tea and brandy, with opium and quinia, furnish the means for restoring normal circulation and nutrition. Indeed, I have treated such cases with *beef-essence* alone with excellent results.

687. *Enfeebled circulation and nutrition* is the principal cause of delirium in asthenic diseases. In this case the delirium is *passive*—it is said the *mind wanders*—there is no action corresponding to the mental excitement. We recognize this case by the pallid face, dull and sunken eyes, cool head, and bodily quietude. In the milder cases the patient sleeps more or less; in the severe cases there is sleeplessness, and these are always to be regarded as serious.

688. The treatment of this case is strictly restorative, and embraces all those means which improve digestion, assimilation, and nutrition. We will frequently find that such a delirium passes rapidly away, when we have placed the stomach in such condition that a pint or more of milk or beef-tea can be appropriated during a twenty-four hours. Alcoholic stimulants can frequently be employed with advantage. Opium, camphor, and quinia in combination, furnish an excellent means for restoring normal activity to the brain, and strychnia and phosphorus will be found useful agents where it is of long duration, especially during convalescence.

689. *Puerperal mania* is usually dependent upon this condition, though occasionally we meet with an exceptional case in which

it is owing to determination of blood. It arises from three prinpal causes—debility from excessive discharges, as hemorrhage and profuse lochia; from a scanty and innutritious diet, and from undue lactation. I have carefully examined the reports of cases. and I doubt whether there is one case in a hundred, where one or other of these conditions has not been the real cause. All the cases I have ever seen were so markedly dependent upon debility produced in these ways, that they could not be mistaken.

690. I regard the old methods of dieting the parturient female as being the most frequent cause, as it is also the cause of much other debility and disease. Parturition is not a disease to be treated with tea and toast—an *antiphlogistic* regimen for fear of inflammation—but a physiological condition, in which the body requires a good supply of food to antagonize the waste from the temporary discharges, and for the nutrition of mother and child.

691. In puerperal mania the treatment is almost wholly restorative. The stomach is placed in good condition for digestion, and the appetite increased by the judicious use of bitter tonics and iron. Gentle stimulation of the brain, by the employment of small doses of strychnia, phosphorus, and quinia, and such means as restore normal excretion, make a treatment that has been very successful.

692. *Change in the condition of the blood* is an occasional cause of delirium. The characteristic delirium of typhoid fever—typhomania—is undoubtedly dependent to some extent upon this. The presence of *urea* in the blood is occasionally the cause of delirium, and we have reason to believe that some other animal poisons act in the same manner.

693. *Hydrophobia* is a marked example of this lesion. There is no doubt that the virus is an animal poison, and is innocuous unless it gets entrance into the blood. Post-mortem examinations show no physical lesions to account for the mental disturbance. Dr. Gross reports such a case, in which "no lesion could be detected by the closest scrutiny. The mouth, fauces, pharynx, and œsophagus; the larynx, trachea, and bronchial tubes, where disease might naturally be supposed to exist under such circum-

stances, were perfectly free from morbid appearances. The *brain and spinal cord,* lungs, stomach, bowels, and other viscera, were equally sound."

694. *Perverted nutrition,* as a cause of delirium, has not been fully studied, yet I have no doubt that it is an important element in the more chronic forms. The processes of nature are so subtle, and her primary organic forms so alike to our senses, even when aided by the highest magnifying power, that we are unable to detect many such lesions. I need but call the reader's attention to Virchow's confessed inability to determine the difference between a white corpuscle of the blood and a pus-cell, or our inability to determine from a view of a formative cell what structure it will form, as evidence of this.

THE EMOTIONS.

695. There are certain mental actions termed emotional, which seem to be inherent in the constitution of the mind, and, unlike others, are not developed by reason or volition. These have been termed *emotions;* but though the word used to designate them conveys a general idea of the nature of this action to the reader, metaphysicians are not yet agreed as to the exact activities to be represented by it. All are agreed, however, that *fear, anger, love, grief, joy, hope, despondence,* are to be included. Carpenter designates a great variety of mental activities as emotional. He says: "In fact, the association of *sensorial pleasure* with *any idea* or *class of ideas* gives to it an emotional character; so that the emotional states are not by any means limited within the categories which most psychologists have attempted to lay down." For our purpose, it is sufficient to designate an emotion as that act of the mind which is not dependent upon reason, or upon an exercise of the will, though it may be controlled and directed by either, or be entirely independent of such control or direction.

696. The emotions are divided into two classes, the ***depressing***

and the *exciting;* in the first are included *fear, grief,* and *despondence;* in the second, *anger, love, joy,* and *hope.* Though there are some grounds for such a division, yet it is not a correct basis, and is liable to lead the student into error. Excessive emotion, of whatever character, is exhaustive—first mentally, and then, reacting on the body at large, physical exhaustion results. There is that love which in its excess destroys equally with grief or despondence; and we have numerous examples of that intense emotion of joy which resulted in death, as well as of its opposite, fear, which has frequently been the cause of sudden death.

697. We do not understand how the emotional states influence the vegetative functions; but that they do exert such an influence is beyond dispute. The most prominent example that we have is the influence of the emotions upon the milk of the mother, and thence on the child. Many cases are recorded where derangement of the bowels, fever, extreme restlessness, convulsions, and even death, have been the result of violent anger, grief, or even joy. I have seen several instances of the first and second, and one of the third. In some of these cases it was not the result of depression, but followed the stage of excitement.

698. If this is so, we can well understand the influences of emotional excitement in producing and influencing diseased action; and the importance of controlling this automatic mental activity, and of directing it in such channels as may lead to beneficial results.

699. *Excess* of the emotions, whether exciting or depressing, leads to nervous exhaustion, and finally to physical debility. Of course this is most marked with the depressing emotions which, even in slight degree, produce temporary debility. If to any serious disease, either acute or chronic, there is added *fear* of an unfavorable result, the prognosis is not nearly so favorable. We have a marked example of this excess in *hysteria;* indeed, it forms a considerable part of this affection; for if the emotions can be brought under the influence of reason and the will, so as to be controlled and directed, the hysteria is at an end. The disease may also be arrested by fear; thus, a threat of a severe operation

or treatment, as the application of a hot iron, shaving the head and application of a blister, is almost always sufficient for the purpose.

700. The object in the treatment of these cases is to place the emotions under the influence of the reason and will. This is accomplished both by controlling the emotional impulse, and by strengthening the will, and is based upon the universal law *that exercise gives strength.* The success of treatment will depend, in the severer cases, upon the influeuce of the will of the person immediately associated with the sufferer, which has to take the place of the will of the sufferer. This control being established, we proceed to develop the reasoning power by its exercise, and volition by the outbirth of these mental processes in bodily action. I think that success is certain, no matter how great the ascendency of the emotional action of the mind, whether in child or adult, if the mental treatment is based upon these principles.

701. *Defect* of the emotions is not so frequently observed, and yet we occasionally meet a case in which the impassivity is remarkable, the person seeming to be wholly unconscious of the joys and fears that make up so much of the life of man. There are cases in which this unnatural mental condition influences the general health in a marked manner. It generally manifests itself in inactivity of the processes of nutrition and waste, and consequent functional inaction. The person presents a peculiar stolid appearance, and the tissues seem to sit badly upon the form, so as to at once convey the impression of a lower animal life. Expression, as produced by the superficial muscles is markedly deficient, and the skin is sallow, doughy, and lacks resiliency. Such cases are met with in almost every section of country, and are remarkably stubborn and difficult to cure. In a minor degree, we will find the same condition influencing many chronic forms of disease, and it is always well to take it into consideration and use such means as will overcome it.

702. In the treatment of such cases we endeavor to interest the person in the life that is passing around him, and make him *a participator* in the joy and sorrow, the love and hope of those

who are associated with him. The cases are very rare in which the emotions can not be developed by carefully drawing the person into the social life of the neighborhood. A very remarkable case of this kind that I treated, attributed his recovery in good part to reading the works of Dickens. If the matter is taken hold of with proper spirit, there will always be some means of engaging the patient's attention on such subjects as will necessarily bring the emotions into play.

703. *Perversion* of the emotions is one element of insanity; indeed, it forms one variety of it. It is also met with occasionally in females who are subjects of hysteria, and occasionally when there is no marked manifestations of this disease. The case will be recognized by the fact that the emotions are untimely and have no proper exciting cause; there is also, quite frequently, such outward manifestation of them as renders the person quite singular. The treatment of this case will be very similar to that named for excess of the emotions. Such means as will cultivate and strengthen the reason and will, and thus give them command over the emotions, will prove successful.

704. In all of these cases the medicinal means will be directed to improving the general health, for just in proportion as the bodily health is good may we expect success in the mental treatment. Tonics and restoratives, with a good nutritious diet, means to promote secretion, and exercise, renew the physical life of the individual; and as the brain, the instrument of mind, is thereby improved in its condition, we may expect that the mental acts will be better. But it will not do for the physician to confine himself to physical agencies alone, but he must bring to bear those subtle influences of mind which exert so important an influence on man's life. I think there is no subject more important than psychological medicine, even in ordinary practice, as there is none that will better repay careful investigation.

VOLITION.

705. We may define volition to be that controlling act of the mind which individualizes the person. A man becomes distinct and powerful in proportion to the strength of his will. Indeed, we may regard it as the source of his individuality, and a *direct power*, not only as it controls his own body, but in its influence on other men and the world at large. Dr. Carpenter, after speaking of different bodily acts, remarks: "Force must be regarded as the direct expression or manifestation of the mental state which we call the Will. The analogy becomes stronger when we trace it into the relations which these two agencies respectively bear to matter. For, in the phenomenon of voluntary movement, we can scarcely avoid seeing that mind is *one* of the dynamical agencies which is capable of acting on matter." Further on he remarks: "On the other hand, in the control and direction which the will has the power of exerting over the course of the thoughts we have the evidence of a new and independent, which is entirely opposed in its very nature to all the automatic tendencies, and which, according as it is habitually exerted, tends to render the individual a *free agent*. And truly, in the existence of this power, which is capable of dominating over the very highest of those operations that we know of as connected with corporeal states, we find a better evidence than we gain from the study of any other part of our psychical nature, that *there is* an entity wherein man's nobility essentially consists, which does not depend for its existence on any play of physical or vital forces, but makes these subservient to its determinations. It is, in fact, in virtue of the will that we are *not* mere thinking automata, mere puppets to be pulled by suggesting strings, capable of being played upon by every one who shall have made himself master of our springs of action. It may be freely admitted that such thinking automata *do* exist, for there are many individuals whose will has never been called into due exercise, and who gradually almost entirely lose the power of exerting it, becoming the mere creatures of habit and impulse; and there are others in whom such

states are of occasional occurrence; while in others, again, they may be artificially induced."

706. Regarding the will as a real power or force, and capable of influencing many functions directly, and all organic acts indirectly, the importance of its study will be apparent. Any one who has not already witnessed the evidences of this, can readily satisfy himself by a few months' observation. Possibly the most important fact connected with volition as an element in disease and its cure, is the fact that to some extent it does govern development, and by its judicious exercise the most perfect development may be attained. It was the exercise of a powerful will that developed the muscular power of Dr. Windship to the extent of lifting 2,100 pounds, just as it requires the exercise of the will to develop any portion of the body to adapt it to a special calling. Mental development is almost wholly controlled by it, and taking the original power of mind of any individual, we may say that its development is in exact ratio to the volition. All things are possible to those who have this power of volition in full degree, providing nature's methods are observed in attaining the desired end.

707. The influence of the will is most marked in disease. In some persons it so controls all mental processes, and indirectly all organic processes, that it is a real antagonist of diseased action; such persons throw off disease because they will not be sick. I do not say that a man can always resist disease by the influence of the will, but the fact that he can occasionally do so shows its importance.

708. Volition is susceptible of cultivation by exercise, like all other faculties and functions of the body, and it becomes impaired by disease. A very important part of the mental training of children is, as I believe, the development of the will in association with reason and the better emotions. While the idea that some seem to entertain, that it is necessary to break the child's will, in order to get obedience and a correct life, is false both in theory and its results.

709. Occasionally we meet with a case, in which both bodily and mental disease result from *excessive* volition. The force is more powerful than the machinery it operates, and sooner or later there must be giving way of some parts of the mechanism. This is just as true of the mind and body as it is of any piece of machinery, and should be as much regarded by the physician as it is by the mechanic. The cases are quite frequent in which a man with powerful will bends every energy to the accomplishment of a certain object; many difficulties are met with, and we notice that in the powerful effort to overcome them the vegetative functions of the body are impaired, and the person loses flesh and strength and the power for its reproduction. As the struggle continues we notice a morbid irritability of some functions of the mind, with occasional evidences of yielding to the strain, just as we observe an overburdened machine vibrate and quiver from a labor disproportionate to the structure; and if such struggle should continue, the body will be irreparably injured, or the mind will give way.

710. It is very difficult to treat such cases, unless the person is capable of appreciating these facts, and by strength of reasoning power change the direction of the will. It is not to be supposed that because a person has a powerful will, on this account a person can change his habits of thought and action at once; the fact is, that it is more difficult than it would be with another person of feeble mind and feeble will. Certain channels or methods of action having been established by long exercise, these powerful acts of the mind seem to flow through them from habit, just as we observe certain co-ordinated muscular movements, which were originally produced by the will, continued by habit, and becoming almost automatic. It requires, therefore, a very clear perception upon the part of the sufferer, and the full power of his reason, which, if continued, will overcome this excess.

711. *Defective* volition is of very frequent occurrence, so much so that in a majority of cases of chronic disease it is met with to a greater or less extent, and occasionally in acute affections. Many times it seems that an appropriate treatment fails simply because

the patient has not sufficient will to get well. At other times certain parts of the treatment are omitted or imperfectly used, because of this defect of volition. A certain amount of exercise is ordered, or a bath is to be taken, or an unpleasant medicine, or more frequently a particular diet, but the patient's will is too feeble to carry out the directions. The most marked examples we meet with, are those who have so lost volition that they can not restrain their appetites. One will suffer from intemperance in eating, another from intemperance in drinking, while excess in venery, masturbation, and the various vices of civilized life, will be found too much for others.

712. It has long been remarked that the patient who had a determined will to live, would almost surely recover, unless from the nature of the disease it was almost necessarily fatal; while, on the contrary, those who did not seem to exert any power in this direction would succumb to slight maladies; so that faith in the physician, and a will to get well, have come to be regarded as important elements in a cure.

713. The will is strengthened by exercise, like all other functions, and it may be called into action both by the exercise of reason and the emotions. If this proposition is clearly appreciated, the treatment of such cases must be plain. If the will is naturally feeble, we adopt such mental exercise as will call it into play. It is very important that it be called into action in such channels as will prove beneficial, and that it be associated with physical activity; for in this we get increased nutritive and functional power, and the brain, the instrument through which the will acts, participates in this. In some chronic diseases, such as phthisis, the only hope for recovery is in the establishment of this power of the will—a determination to get well; while in the severer acute diseases it is also of importance—a will to get well paving the way to recovery.

714. *Voluntary Motion.*—Voluntary motion is the result of the direct action of mind through the will on the muscles of the body. It is strong in proportion to the development of the muscles and

power of the will; indeed, we may regard the muscles as the mechanism, the will as the force. For normal voluntary motion, then, the following conditions are necessary: *First*, a normal development of muscular tissue; *second*, its supply of innervation from a healthy brain through the motor nerves; and, *third*, volition, or power of the will.

715. We occasionally observe an *increase* of voluntary motion during delirium, when the reason being perverted, and volition directed by it, the excitement of the nerve-structure, caused by increased circulation, is expended through the muscles.

716. *Defective* voluntary motion is associated with defective volition, and also with an enfeebled condition of the muscles, or an obstruction to the passage of nerve force. In motor paralysis there is a lesion of the nerve centers arresting the development of nerve force, or a lesion in the course of the nerves of communication which obstructs its flow. Any disease that will arrest functional activity of the brain will cause paralysis. In some cases it is dependent upon an inflammatory condition, and in such the remedies for an inflammation will be the appropriate ones. In other cases it is dependent upon feeble circulation or congestion, and it is treated with belladonna, strychnia, ergot, etc. In other cases it results from compression of the brain by the extravasation of blood, as in apoplexy, or effusion from the serous membranes; in such cases remedies that promote absorption are appropriate. And in a last class of cases, it is caused by disease which destroys the substance of the brain, and is necessarily irremediable.

SENSATION.

717. It is very desirable to locate precisely the function of sensibility, especially as there is much discrepancy in the writings on the subject. If we determine what the function is, and of what particular part, we will be enabled to define its pathological changes and adopt a rational therapeutics.

718. Dr. Williams divides sensibility into *centric* and *local*, the first originating in the brain and spinal cord, the second in the part where it is manifested. In disease we recognize such a distinction to a certain extent; but if we base our practice exclusively upon it we will be unsuccessful.

719. Dr. Carpenter describes this function accurately when he says: "By the term *sensation* is rightly understood that change in the condition of the mind by which we become aware of an *impression* made upon some part of the body; or, in a briefer form of expression, it may be defined to be the *consciousness of an impression*. Some physiologists have, it is true, spoken of a *sensation without consciousness;* but it seems very desirable to limit the term to the mental change, since the word *impression* serves to designate the change produced in the afferent nerves by an external cause, up to the point at which the mind becomes conscious of it."

720. Man's conscious existence being wholly in the brain, and sensation being dependent upon it, we necessarily conclude that sensation is a function of the brain alone. When, from any cause, the functions of the brain are suspended, there is no longer sensibility, no matter how strong the external impression may be. Being a function of the brain, we will find it influenced by all abnormal conditions of this organ; and conversely, we will find lesions of sensation to influence the circulation, nutrition, and functional activities of the brain, and through it the body at large.

721. Disease of a part involving the structure of its nerves, or the conditions of their action, gives us local lesions of sensibility; and, although the consciousness of this is wholly a function of the brain, yet the cause being local, our therapeutics are directed to the local disease. We may, therefore, consider these lesions as general and local, bearing in mind the distinctions above made.

722. *Excessive general sensibility* arises from two causes, which, being almost directly antagonistic, require to be accurately determined in every case, if we wish a successful treatment. The

first of these is an irritation with determination of blood to the brain, the excitement of the organ being manifested in an increased general sensibility, and occasionally of the special senses. The second arises from that irritable condition of the brain that attends a feeble circulation and nutrition, and is popularly expressed by the term irritability.

723. In ordinary determination of blood to the brain, or the first stage of inflammation, this excess of sensibility is usually marked. Usually it takes the form of a general increase in the susceptibility to impressions, but in other cases it has also a local manifestation—as a headache, intolerance of light and sound, etc. In sthenic fevers and inflammations it is frequently noticed, and is the cause of the greater part of the suffering. Occasionally we meet with a very marked case, as of extreme intolerance of light and sound, and such exquisite general sensibility that ordinary impressions produce pain

724. Intimately associated with this is the action of certain morbid material in the blood upon the brain. We may attribute such action to its ability to produce irritation of that organ, or to influence its nutrition; but, in whatever way it may act, the fact is evident that such material in the blood does occasion this derangement of function, and that its removal by way of the excretions is the proper mode, as it is frequently the only one, of getting rid of the nervous trouble. As instances of this, I may call attention to a very persistent headache, with increased sensibility, which is undoubtedly dependent upon retention in the blood of the urinary solids, and which is cured by the administration of the alkaline diuretics. I doubt not, almost every practicing physician has seen cases in which local pain and irritability have been relieved only when the excretions have been fully established. I recollect a case of extreme sensibility of the eyes, of many months' duration, which had resisted all ordinary means of cure, relieved in two weeks' time by the administration of small doses of podophyllin, and acetate of potash in usual quantity.

725. The second class of cases, in which the excess of sensibility is due to an enfeebled condition of the brain, is quite numerous, and many errors in treatment are due to a want of recognition of this cause. We meet with it in persons of feeble health, in whom there is manifest deficiency of blood, and necessarily a feeble nutrition. Such persons are said to be *nervous* or *sensitive*, and the popular opinion that such nervousness or sensibility is due to debility, is correct.

726. Not only do we find such general increase of sensibility to be due to debility, but many cases of local pain—neuralgia—have the same cause. We recognize such cases by the pallid surface, feeble circulation, and want of functional activity; and as is well known, such cases are cured by a tonic and stimulant treatment, and a nutritious diet.

727. *Defective general sensibility* may be dependent upon one of three causes—an enfeebled circulation, impaired nutrition, and the presence of some foreign material in the blood. The condition is readily recognized as an unnatural obtuseness to ordinary impressions, and is usually associated with general dullness or hebetude and deficient reasoning power and volition; and continuing to increase, it gives that condition termed coma.

728. We have this defect in minor degree, from a simple atony of the brain from a deficient circulation of blood in the brain. We have the more marked defect when there is that condition of the circulation known as congestion. Occasionally we meet with a case of feeble vision, or partial deafness, which has its origin in this atony, and which is cured by establishing a normal circulation of blood.

729. Impaired nutrition of the brain is occasionally a cause of defective sensibility. The most marked example is that condition termed *softening of the brain*, yet we have other instances in which impairment of the special senses is due to this cause.

730. *Paralysis* of sensation arises from both of these causes, the first being temporary, the second more or less permanent. We can occasionally determine the first condition pretty accurately, and can promise the patient a speedy recovery; but occa-

sionally we have much difficulty in determining the exact condition. Then there is undoubtedly a lesion beyond the physical structure of the brain, that causes paralysis. With our feeble means of examining the minute structures that form all tissue, and our entire inability to account for differences in cell action, we cannot determine the causes of functional wrongs. There are processes in life, both in health and disease, that we may witness, and observe the general laws of action, but the causes of which we are wholly unable to fathom.

731. As a general rule, the presence of morbid material in the blood either depresses or increases general sensibility. We have a marked example of the first in the influence of both animal and vegetable malaria in the forming and cold stages of fevers. We also notice the same influence in the eruptive fevers. Again, in the later stages of the same diseases, we occasionally find this defect from the presence of effete material in the blood. Uræmia, the coma that follows retention of urea, is another marked example, and analogous to it is the action of that class of remedies called narcotics.

732. *Perverted general sensibility* is not of frequent occurrence, and yet we occasionally see instances of it. Formication, sensations of chill or cold, when the surface is warm, intense burning or itching without cause, are examples. Dr. Williams enumerates the following: " Feeling of tingling, prickly heat, trickling cold in various parts, of a lump in the throat, a hot ball in the side, a fluttering at the stomach, and illusions of the special senses, severally and variously affect persons whose sensibility is modified more in kind than in degree. Such patients may also have a depraved appetite, craving for sour things, cinders, mortar, and all manner of filth. These symptoms generally occur in females, often in connection with irregular menstruation, and, therefore, are called hysterical; but their pathological cause must be sought in the nervous system, the functions of which become deranged, probably from irregular circulation or the bad quality of the blood supplied to them."

733. *Excessive local sensibility*, when marked, is pain, and may arise like excessive general sensibility from the two causes—irritation and determination of blood to the part, or an enfeebled condition of the part. To this might be added a third condition, in which, from change in the relation and situation of parts, the nerves distributed to them are irritated.

734. The pain that attends all inflammatory processes may be taken as an example of the first cause. We have little difficulty in recognizing this case, as the three other symptoms of inflammation, heat, redness, and swelling, are associated with it; but in some cases of neuralgia the diagnosis is more obscure. If it is superficial we will usually find an increased temperature and slight redness, as well as an increase of tactile sensibility in the part. In deep-seated parts we have but the general symptoms to guide us—the full, strong pulse, and general excitation of the entire system.

735. In the second case the part is cool, frequently pallid, and we have the evidence of our senses that it is enfeebled. In deep-seated parts we are guided by the general symptoms—the soft open pulse, cool surface, cold extremities, and depressed general sensibility. The reader will observe that these two conditions are directly opposite, the only agreement being that they both cause pain; and when we come to speak of the therapeutics of neuralgia we will find that the treatment is wholly different.

736. We rarely have *defective local sensibility* as an element of disease. Occasionally it seems that the nutrition of a part is influenced by this, but it is only in the repair of injuries that we give any attention to it. In such cases the use of such remedies as stimulate the nerves of the part are beneficial. Occasionally we meet a local paralysis of sensation in which there is no lesion of the brain; but in such cases there is generally some disease in the course of the nerves supplying the part that occasions the defect.

737. *Perverted local sensibility* is occasionally met with. The most marked examples are in the organs of special sense, as in amaurosis from disease of the retina, and in some derangements

of the sense of hearing. The flashes of light, sparks of fire, and sundry appearances known as *muscæ volitantes*, are seen as well in amaurosis from the local lesion as from the lesion of the brain; while roaring in the ears, the sound of bells, voices, and other derangements occur in local disease, involving the auditory nerve. We observe the local sensations of formication, tingling, pricking, of intense heat or cold, and other analogous symptoms that were mentioned under the head of perverted local sensibility.

738. *Treatment.*—If the reader has properly appreciated the distinctions we have made while describing these lesions of sensation, the appropriate treatment for each will have been suggested as they were considered; but if those distinctions are not made, there will be many failures in treatment.

739. In *excessive* sensibility from irritation and determination of blood to the brain, we direct the special sedatives with gelseminum, evaporating lotions to the head, the hot foot-bath, and occasionally counter-irritation to other parts. Where nothing contraindicates, a cooling purgative may be given, and this followed by a saline diuretic. The same general means are appropriate in excessive local sensibility from irritation and determination. The local means in these cases consist in cold applications, evaporating lotions, dry or wet cups, leeches, hot fomentations, poultices, and sedative and narcotic applications.

740. Following the general means above-named, opium, or the salts of morphia may be given to arrest pain and produce sleep. The hypodermic use of morphia will frequently prove very beneficial in these cases; but, as prostration follows over-excitation, the use of bitter tonics and restoratives, and a nutritious diet, should at once follow the means named.

741. Excess of sensibility from a morbid material in the circulation, will require the use of such remedies as will neutralize its influence in the blood, and remove it by way of the excretory organs. The action of quinia in periodic neuralgia is an example of the first action; while the relief of pain and excessive sensi-

bility by the action of diaphoretics, diuretics, and cathartics, is well known.

742. *Excessive* sensibility from feebleness is treated with quinia, the mineral acids, phosphorus, the stomachic bitters and an abundant nutritious diet. Stimulant doses of opium, and occasionally alcoholic liquors, are employed with advantage. In low fevers the extreme sensibility and morbid wakefulness can only be treated with restoratives. I have frequently seen sleep follow a few ounces of beef-tea or milk, or even an enema of beef-tea, when drugs had failed to produce it. The marked benefit of a combination of opium, camphor, and quinia, is due to its stimulant and restorative action on the brain. In these cases the first indication of cure is to place the stomach in condition to receive and digest a portion of food, and then follow with the tonics and restoratives as above named.

743. Headache is frequently cured by quinia, strychnia, a cup of hot tea even, or by alcoholic stimulants, ether, or chloroform. Neuralgia of other parts is cured by the same means. In this case the local applications are stimulant. Other than the hypodermic use of morphia, we employ rubefacients, dry heat, direct dry-cupping, shampooing, and similar means.

744. *Defective* general sensibility is treated by the use of stimulants, tonics, and restoratives, and nutritious food. When dependent upon an enfeebled circulation, the use of diffusible stimulants, alcoholic liquors, strychnia and quinia, are proper. When from impaired nutrition, we restore the function of the stomach, and promote the appetite, aid the process of digestion, and by the use of restoratives and food furnish the material for nutrition All that is now required is a free circulation of blood, and such exercise as will promote a rapid renewal of tissue. When from the presence of a morbid material in the blood, its renewal is to be conducted in the manner heretofore named.

745. The treatment of *paralysis* of sensation will vary according to the cause that produced it, as we have heretofore seen ; in the one case it will demand means to lessen irritation and deter-

mination, in another it will require such means as will stimulate and call the nervous center into play.

746. Defective local sensibility is treated by the local application of stimulants and rubefacients, direct cupping, shampooing, dry or moist heat, and similar means.

747. *Perverted* sensibility will have to be treated according to the cause that has produced it. It is very frequently from an irregular circulation of blood, sometimes from effete material in the blood, and again from impaired nutrition. Each of these will suggest the proper medication.

PAIN.

748. Pain is so common, such an important element of disease, that it deserves special consideration. Disease is always unpleasant; indeed, one of the most common evidences of disease is a want of pleasure in the performance of function. Going one step further, and this want of pleasure gives those disagreeable sensations which, when not designated as pain, are a source of great discomfort.

749. Studying pain as an element of disease, we soon reach the conclusion that it is but a symptom or expression of some wrong of the body, and if so, then the disease producing it should be treated, instead of prescribing for the pain. It is true this is not the method of the common practice of medicine, for this seems to regard the pain as the disease, and prescribes remedies to arrest it. Thus, of opium and its salts some millions of dollars worth are used yearly in this country; and of chloral, the most fashionable remedy for pain, it is consumed by *tons*.

750. Conceding, then, that pain is but a symptom of disease, we wish to know what conditions give rise to it, and how they may be relieved, for when the disease is removed the pain ceases. The cause of pain may be in the part that suffers; in the brain, that receives the impression; in the body at large, or in a distant part.

Some of these poiuts have already had a consideration under the head of sensibility, but we will do well to think of them again.

751. The cause of pain may be wholly in the part suffering, as we see in many structural diseases. A thorn or splinter in the flesh, a sequestrum of bone, a corn or bunion, an ingrowing nail, a carious tooth, a cinder in the eye, etc , are familiar examples of a local cause of pain. Would any sane man give opium, morphia, or chloral to arrest such pain? Rather remove the thorn, splinter, bone, tooth or cinder, and by removing the cause of offence, stop the pain. The rule in these cases is so plain " that he who runs may read "—remove the cause, and the pain will stop.

752. It would not be a wise physician who would administer opium or chloral to relieve the pain of a distended bladder—better remove the urine. It would not be better treatment to administer narcotics to relieve the pain in stomach or bowels, caused by irritant materials, or a uterine pain having as its object the expulsion of a dead fœtus, and yet such treatment is very common. Again the rule applies—causes of irritation must be removed.

753. In other cases inflammation and its results sufficiently account for the pain. The irritation, determination of blood, distension of vessels, increased heat, effusion, etc., are the causes of pain; and a rational treatment would look to the arrest of the inflammatory process, and the restoration of the part to its normal condition, rather than to narcotics which benumb the brain so that it can not feel the wrong. If in the early stage we use means to arrest the irritation and stop the determination of blood, we will relieve the pain. If later, we use means to start the circulation in the enfeebled capillaries, and cause absorption of the effusion, we will stop the pain. When suppuration occurs the pain changes its character, and is evidently due to the pressure of pus, and a good treatment relieves pain by giving this pus escape.

754. Outside of these cases, the pain of a part may be due to less marked conditions of it, as we see in many cases of neural-

gia. I think we may clearly divide these lesions into three groups: (*a*) tonic, with vascular excitement; (*b*) atonic, with enfeebled circulation; (*c*) with wrongs of nutrition or cell-growth. In one case we find the part is flushed, its temperature slightly increased, and common sensation increased. The condition is clear, and the local remedies are at once suggested—sedative applications—the local application of veratrum, aconite, cold, moist heat, etc. In the second case the part is pallid, cool, and its common sensation diminished. The treatment here also is plain—the use of stimulants, as the essential oils, mustard, capsicum, heat, etc. The third class of cases is not so easily diagnosed, and yet many times we will have reason to suspect the nutritive lesion. Salicylic acid, sulphate of zinc, carbolic acid, chlorate of potash, thymol, baptisia, phytolacca, etc., are remedies suggested by special symptoms.

755. As we think of the subject in this way, the absurdity of invariable prescriptions will be clearly seen. If a physician says he always uses a cold pack, or a certain fomentation or poultice, or a certain favorite liniment or plaster, to relieve pain, we "write him down an ass," because he certainly can never have studied the causes of pain.

756. But as we have already seen, a part can have no sensation without the brain, and whilst the wrong done to the nerves of the part may give the normal brain the sense of suffering, so also may the abnormal brain be so sensitive that ordinary impressions cause pain; we have a great many cases of this kind, and when pain is persistent we should always take it into consideration. The wrongs of the brain producing pain may be grouped in three classes: (*a*) of irritation, with circulation increased; (*b*) of atony, with circulation diminished; (*c*) with change of condition. The first is marked by the bright eyes, flushed face, increased heat of the scalp, restlessness and sleeplessness. The remedies indicated are such as remove the irritation, and stop the determination of blood, as gelseminum, the sedatives, counter-irritants, etc. The second condition is marked by the pallid face, dull eyes, expressionless face, and indisposition to exertion. It is treated with

nerve stimulants, as the ammonias, ether, stimulant doses of opium, etc. The perversion of the brain will be shown by special symptoms, and fortunately these indicate the remedies, as the contraction about the eyes with burning, calling for rhus; flushed right cheek, bryonia; dull and sleepy, belladonna; uneasiness in back of head and neck, sticta, etc.

757. The general wrongs which cause pain are very many, and we will do well to estimate them at their true value. Simple frequency of pulse with increased temperature may be the difference between normal sensation and acute pain, and the means which bring the pulse and temperature back to the normal standard, the speediest and most certain means of relief. A wrong of the sympathetic nervous system, governing the vegetative processes, may be the cause of pain, and means that give right innervation through this are our most certain means of relief. The expressions of such disease are seen in many ways, and we note them and their relationship to remedies as best we may; sometimes it is a peculiar trill of the pulse as if a cord was being untwisted under our finger, or the sharp strokes of the blood-wave as it strikes our fingers, calling for rhus; a continuous cord in the pulse, calling for bryonia; a full, oppressed pulse, calling for lobelia; a full, free pulse, eupatorium perf; a small, empty pulse, opium; venous fullness, podophyllum, etc. It may be the color of the surface or mucous membrane—as the purplish hue of face calling for baptisia, the violet color of tongue calling for nitric acid, vivid redness calling for rhus, pink coloration suggesting apis, pallor carbo-veg., transparency copper, etc.

758. The wrongs may be of the blood, as we see in simple excess or deficiency of its salts, in the presence of retained excreta, from changes or defects in retrograde metamorphosis, from vegetable or animal malaria, zymotic posions, etc. The first is very common, and, as our readers have proven many times, I have no doubt, is relieved by an acid in the one case, or an alkali in the other. There is no fact better established than that pain depending on retained excreta is best cured by establishing excretion from skin, kidneys, and bowels. Rheumatism is a fair

example of pain from a wrong in retrograde metamorphosis, though by no means the only one, and we call to mind the favorable action of the alkaline diuretics, and similar means, in its relief. The decided periodicity in some cases of pain, and the equally decided curative action of quinine, are facts well known to the profession. We could hardly expect to find a physician doing so absurd a thing as to give narcotics in cases where pain was distinctly periodic, and yet it is not more absurd in this than in other cases. The pain associated with zymosis is relieved by anti-zymotics, as we see in the administration of sulphurous acid, the sulphites, muriatic acid, chlorate of potash, baptisia, etc.

759. This is a very brief presentation of the subject, but I hope it will show that a rational treatment of pain requires a careful study of all the conditions that may give rise to it, and that the common use of narcotics to obtund the brain so that it may not be able to feel the wrong, is bad practice.

THE SPINAL CORD.

760. The spinal cord is a true nervous center, independent of the brain on the one hand, and the sympathetic ganglia on the other, and yet associated with both in action. It controls all the *automatic* movements of the body, and is thus essential to the performance of several very important functions. The respiratory function is wholly under its control, though the use of the lungs is permitted the brain in calling into the action the vocal organs. The act of deglutition is also performed under its direction, as well as defecation and urination. To what extent it influences the movements of the intestinal tube we do not know, and yet we have evidence that it does exert such an influence. Dr. Carpenter remarks: "Although its attributes as an independent center become most obvious when it is separated from the rest, yet there can be no reasonable doubt that it is always acting as such, even when every part of the nervous system is in a state *of comple* vigor. It may, in fact, be said to supply by its 'reflex

power' *the conditions requisite for the maintenance of the various organic processes.*"

761. Its association in action with the sympathetic system is very marked, and frequently spinal and sympathetic nerves are associated in the formation of a plexus, and together give the nervous supply. Indeed, if we consider the *pneumogastric* as a spinal nerve, there is not a sympathetic plexus in the body but what has its supply of spinal nerves. The intimacy of this association is marked in disease, very frequently a lesion of some viscus supplied with sympathetic nerves, becoming manifest in disease of the spinal center; and conversely, the disease of the spinal center will affect the function and even structure of the viscus. This associated action is remarkably shown in the irritation of the spinal cord from visceral disease, which results in spasmodic action.

762. One of the most important functions of the spinal cord is its power of assuming control over all the processes of life, and, as it were, directing every function. Every voluntary muscle receives its supply of spinal nerves, and is to a certain extent under the influence of this center. All natural automatic movements being directed by it, we find them as nearly perfect in co-ordinated movement of muscles as is possible. Witness the act of sucking in the new-born child, or the function of respiration. There is reason to believe that co-ordination of movement has its origin in the spinal center, for we find that as any movement attains perfection, it also becomes automatic, or at least the exercise of the will is unconscious. Training in any muscular movement accomplishes this, so that at length these movements are performed without thought.

763. Dr. Marshall Hall's function of *reflex action* does not exist as described by him. The spinal cord receives its impressions direct, it is true, and these impressions originate a corresponding muscular movement which is more perfectly adapted to the end than anything that is possible under the influence of reason and the will; just as much so as nature's forms are more perfect than the artificial forms made by man. The spinal mechanism resem-

bles those machines now used to perfect the art of the engraver, which being set to a pattern works it out with a delicacy unattained by the hand.

764. We may examine the lesions of the spinal cord with reference to two functions—*automatic movement,* and its association with the ganglionic system in various organic processes. It will be difficult to keep these separated, as some of the principal lesions of automatic movement have their origin in the associated function with the sympathetic.

765. A simple *excess* of this automatic movement is not possible as an element of disease, for it is the perfection of muscular movement. The forced or rapid respiration, occasionally observed, is invariably due, I believe, to a lesion of the lungs, or such change in the blood as prevents oxygenation, and the increased movement is but the endeavor to supply the demand of nature. The contraction of the larynx, observed in irritation and inflammation, would more nearly represent an excess. The violent movements that occur when a small portion of a solid or liquid gets entrance to the larynx, or a bone, splinter, or other solid gets impacted in the fauces or base of the tongue above it, seem to be out of proportion to that required for the removal of the irritation. The irritation in spasmodic croup is hardly sufficient to account for the violent and continued contraction of the larynx, yet in this case there is also a manifest perversion of the automatic movement. Then the continued contraction of the intrinsic muscles of the larynx in croup and laryngitis, is not simply an excess, for the normal movement is contraction alternated with relaxation. Then we have the tenesmus of dysentery, the tenesmus in certain forms of dysuria, the bearing-down pains in some cases of dysmenorrhea, all of which present an excess in the function of the spinal cord, but a perversion as well. In each case the increased action arises from the sensation of an irritant transmitted to the spinal center, and the muscular movement which follows is an effort for its expulsion.

766. *Defect* of automatic movement is frequently met with and is sometimes a very serious lesion. A very marked example of

this is seen in labored or feeble respiration when spinal innervation is depressed by the action of narcotics or alcohol. We observe this defect in some cases of acute disease, in which the defect gradually increases, until it requires an effort of the will, exerted through the external inspiratory muscles, to oxygenate the blood. In such case, if the patient sleeps, we notice a gradual failure of respiratory movement and decarbonization of the blood, until the impression becomes so marked that the person awakes with a sense of impending suffocation, and calls into play the external muscles by an act of the will. Finally in such case, sleep is impossible, for without the constant effort of the will, respiration would cease.

767. Defect of automatic movement is a prominent lesion in many cases of constipation; indeed, in some it seems to be the whole lesion. Hence the success that follows the remedies, and especially the repeated exercise that finally re-establishes this function. In some cases we find this defect in urination, and, though it might seem of little importance, there is nothing more distressing than this tardy or feeble passage of urine. I have seen two cases in which there was not only a continuous defect in marked degree, so that a particular position and much time would be necessary to the act, but in which there was occasionally an entire failure of reflex action, necessitating catheterism.

768. Again, this defect is manifested in *paralysis agitans*, and in *progressive locomotor ataxy;* but apart from these major lesions, there are many cases in which there is evident feebleness of co-ordinated movement. This is especially marked in children after severe attacks of illness, and occasionally in some chronic diseases. A variety of spinal curvature has its origin in this lesion, and occasionally it results in other deformities. Stammering is caused by this defect, and is only cured by such education of the organs as will establish co-ordinate movement.

769. *Perversion* of automatic movement is of frequent occurrence, and is an element of many diseases, and the whole of quite a number. We will name a few of the minor ones first, as we will thus be better enabled to appreciate the lesion. Singultus

or hiccough realizes our idea of such lesion, the movements of the diaphragm being powerful, but having no reference to function. The inordinate tenesmus or peristaltic action from irritation of the rectum and large intestine, urinary apparatus, and uterine organs, frequently presents marked examples of perversion as well as of excess.

770. We might divide this lesion into two forms, in the one of which the action of the mind is not impaired, though voluntary motion is to a greater or less extent arrested; in the other the entire functions of the mind are in complete abeyance. The first class comprises those above named, that muscular contraction known as cramp, tetanus, and some cases of hysterical convulsions. The second class includes epilepsy, and the majority of cases of convulsions.

771. The causes of these lesions are either *centric,* arising within the spinal cord, or *eccentric,* commencing in a distant organ or part, and reflected thence to the spinal cord. The lesions of the spinal cord itself are not well known, but we have reason to believe that they are similar to those of the brain, already described. Irritation, with determination of blood, inflammation, congestion, and enfeebled circulation, defective nutrition, and a morbid material in the circulation, will each produce this lesion: and necessarily the recognition of such cause must precede a rational treatment. The action of an eccentric cause seems to be as follows: An irritation of a part supplied by true spinal and sympathetic nerves being set up, this irritation is transmitted back to the spinal center, and stimulates the generation of motor power. We do not know why it does so, or how the influence is transmitted, and have to remain satisfied with our knowledge of the result.

772. The examples of such eccentric cause are numerous; indeed, the majority of cases of convulsion have this origin. Tetanus has its origin most frequently in a wound of the extremities; and, though the irritation is undoubtedly transmitted by the afferent spinal nerves, we find no anatomical lesion of them. The *spasmodic* contraction of the muscles of the extremities, known

as cramp, arising from intestinal irritation, as in diarrhœa, cholera morbus, and Asiatic cholera, are familiar examples; but quite as common, and as well marked, are the cases of convulsion in children from dental irritation, irritation of the stomach from acrid-ingesta, irritation of the bowels from perverted excretion, or worms, etc.

773. A majority of cases of epilepsy have a like origin. Quite frequently we trace the first attack to crude or irritating ingesta, to an irritation of the bowels, or to a derangement of the menstrual function, or other excitation of the reproductive organs. In many of these cases the cause is evanescent, or at least continues but a comparatively short time, and yet the epilepsy continues. We can account for this in but one way, namely, that abnormal action once established, is the same as automatic or co-ordinated movement, the influence becoming more intense and persistent as the paroxysms are repeated. The hysterical convulsion has a like origin, but more frequently from an irritation of the reproductive organs; and, as is well known, each repetition but strengthens the disease, until at last it seems to be one of the natural actions of the body.

774. *Treatment.*—The treatment of these lesions will depend upon the condition of the spinal cord, and our ability to reach this by direct or indirect medication. Those conditions that show an increased functional activity, but without perversion, will generally be dependent upon irritation and increased circulation in the spinal center. In this case the use of special sedatives, with gelseminum, rhus, bryonia, macrotys, the hot foot-bath, remedies to promote excretion from the skin, kidneys and bowels, and counter- irritation, are the principal means of cure.

775. *Defect* of the automatic movement is dependent upon an enfeebled circulation, morbid material in the circulation, and imperfect nutrition. When there is a feeble circulation, but no stasis of blood, the administration of certain stimulants, as strychnia, ignatia, etc., increases this power. When this has been of long duration, and nutrition is impaired, we employ, in addi-

tion, quinia, various preparations of phosphorus, cod-liver oil, etc. When the defect is dependent upon congestion, we may use the older methods of revulsion, but I prefer the specifics, belladonna, ergot, and bromide of ammonium. The presence of a morbid material in the blood may be neutralized by the administration of an antidote, as when we give quinia for the malarial poison, or belladonna to antagonize the action of opium or urea, or the antiseptics where typhoid symptoms present; or we endeavor to remove such material by stimulating the excretory organs.

776. *Perversion* of the automatic movements is treated by a removal of the exciting cause, the relief of any physical disorder of the spinal center, and by certain remedies that control this nervous action—anti-spasmodics. An example of the first method is in the arrest of cramps of the muscles of the extremities, by the use of remedies that remove the irritation of the bowels; the arrest of convulsions, by an emetic to free the stomach, or a cathartic to free the bowels of irritant material. The permanent removal of hysterical convulsions, by treatment directed to remove the uterine irritation, is a familiar example.

777. When there is an irritation of and increased circulation to the spinal cord, the use of gelseminum, the special sedatives, or indirect sedation by the use of the nauseants, and counter-irritation, furnishes the best plan of treatment. When the perversion is due to congestion, belladonna and ergot are the special remedies, and may be associated with the general treatment for this condition. A feeble circulation, with atony of the spinal center, is frequently met with, and in such case I prefer bromide of ammonium. Strychnia, with quinia, may be occasionally used with advantage. In a similar condition, associated with a feeble action of the sympathetic system, especially as it controls the circulation, benefit is derived from small doses of digitalis.

778. Anti-spasmodic treatment is altogether empirical, and very indefinite, and embraces a large list of remedies. I have been used to class them in the following order, regarding their *power to control spasmodic action*, namely: Lobelia, gelseminum,

chloroform, chloral, bromide of ammonium, ether, asafœtida, other fetid gums, and nauseants in general.

779. The modern treatment of epilepsy by the use of bromide of potassium and bromide of ammonium has been attended with much success, so that it has almost superseded the older methods. Still, Trosseau, one of the most successful physicians in this class of diseases, preferred belladonna, and others have adhered to digitalis.

ASSOCIATION OF THE SPINAL WITH THE SYMPATHETIC SYSTEM.

780. I have spoken of the association of the spinal centers with the ganglionic system of nerves, and we wish now to examine the relation between the two as influencing diseased processes. The anatomical arrangement for such associated action is most perfect; for, not only are there direct communicating fibers between each ganglion and the nervous matter of the spinal cord immediately posterior to it, but every sympathetic plexus receives one or more spinal nerves. We do not understand the physiological action of these centers so well, because all of these actions and functions are without the consciousness of the individual; yet we can readily appreciate such of them as are associated with the conscious functions of the spinal cord—respiration, deglutition, defecation, and urination.

781. We recognize this association of action in certain pathological conditions, because unconscious acts then become conscious and applicable, and because we are able to detect them by the aid of our senses. The law of relation that we wish to study is this, namely, that an irritation of an organ or part supplied principally by sympathetic nerves may be transmitted backward, and occasion a permanent irritation of the spinal cord; and conversely, that an irritation of the spinal cord may originate disease of a distant organ receiving a sympathetic supply, and produce either functional or structural disease. If these are facts, and I

think they are abundantly proven, they open an important field in practical medicine.

782. Among the most common examples of this may be named, the irritation of the lumbar spine in disease of the uterine or pelvic viscera; the irritation of the lower dorsal portion of the cord, in diseases of the kidneys and urinary apparatus; the upper dorsal portion of the cord, in diseases of the stomach and associated viscera; the irritation of the cervical portion of the cord, in diseases of the heart; of the posterior basilar expansion of the cord, in lesions of the reproductive system. Conversely, we will find that a spinal irritation of these parts will exercise a direct influence on the organs named, and if severe, will prevent a cure of the visceral diseases. So that many times it is fully as important that the spinal irritation be treated, as that remedies be given for the visceral disease.

783. I would not confine this to irritation alone; but think, if we examine the subject closely, we will find the three lesions of excess, defect, and perversion. The first has been already named. In the second, the feebleness of spinal innervation is one cause of deficient functional activity of the organs named. Of course, it is difficult to give examples of this that would prove convincing to the skeptic, but the frequent resort to such remedies as exert a special influence on the nervous system, and the marked benefit that follows their use in visceral disease, long since convinced me of the truth of the proposition. Perversion of this influence may also be the cause of some of the singular visceral aberrations that we are unable to account for in the ordinary course of pathological action.

784. *Treatment.*—The common idea of treatment in chronic disease of the spinal cord is, to relieve the irritation by the use of counter-irritation, applied over the part that seems to be affected. Many physicians determining a tenderness on pressure immediately apply an "irritating plaster," or possibly some rubefacient liniment; but while this treatment is correct for a case *where there* is irritation and determination of blood, it is not

always appropriate; and there are other means that may be employed.

785. If, in a given case, there is tenderness on pressure over the spine, increased sensation where the spinal nerves first become cutaneous, a full, slightly hard pulse, contracted pupils, and slight erythism of the entire nervous system, I would regard it as a marked case of irritation of the cord. The internal use of a diuretic salt of potash, keeping the excretions free, and the use of the special sedatives and gelseminum would be the appropriate treatment. Associated with this we might use an "irritating plaster" to induce suppuration, or if the disease was acute, dry or wet cups would answer a good purpose

786. If there was tenderness on pressure, with a feeling of fullness and debility, a soft open pulse, dullness of the eye and immobile pupil, tendency to coldness of the extremities, etc., I should regard it a case of enfeebled circulation, or atony of the spinal cord. In such cases, in addition to a general restorative plan of treatment, we find benefit from the use of belladonna, ergot, and digitalis, in small doses, and also from strychnia, quinia, and bromide of ammonium in other cases. In this case, we use rubefacient liniments and frictions, the belladonna plaster, and some of the many strengthening plasters that stimulate the surface.

THE SYMPATHETIC SYSTEM.

787. The sympathetic or ganglionic system of nerves has its center in a chain of ganglia arranged along the anterior surfaces of the bodies of the vertebra; these being connected by a nervous trunk, it takes the name of the great *sympathetic nerve*, one on each side of the body. We have already seen that there was a very intimate connection between these ganglia and the spinal center, and also in the formation of each sympathetic plexus, which receives a supply of spinal nerves. This anatomical asso-

ciation gives an intimate association of action, so that is is difficult to separate the functions of the two.

788. The distribution of these nerves is different from the other centers. A plexus is formed for the supply of associated organs, and from this the nerves are sent off. They always pass with the blood-vessels, and are distributed with them; indeed, when we leave the chain of ganglia there is no other method of distribution. So far as we know these nerves accompany every artery to its ultimate ramification, and we know that they control the function of circulation, and so far as a nervous system has control, the functions of secretion and nutrition. Hence it has been called the vegetative system of nerves.

789. It is interesting to examine the opinions of authors on this subject. Dr. Carpenter, the most learned, as well as the most profound physiologist of the age, says: "Upon this point we can only surmise; but there appears strong ground for the conclusion that the office of these fibers is to produce a direct influence upon the chemico vital processes concerned in the organic functions of nutrition, secretion, etc.; an influence which, though not essential to the performance of each separate act, may yet be required to harmonize them altogether, and to bring them into connection with mental states. That the nervous system does exert such an agency will be hereafter shown; and reasons will then be assigned for regarding the sympathetic fibers as its principal, if not as its sole channel."

790. Dr. Draper concocts the singular theory that, because the sympathetic nerves transmit sensations slowly, they are magazines for storing up nerve force. That I may not misstate him, I will quote the exact language: "I, therefore, regard the sympathetic system as having for one of its main functions the equalization or balancing of the nervous force, storing up all transient excess of it, and furnishing all transient deficiencies. As in a mechanical contrivance, in which the prime mover works in an irregular way, the fly-wheel harmonizes all such variations, storing up or supplying power as the circumstances may require, so *does this* complicated apparatus act in the mechanism of innerva-

tion." But if we examine the action of the human body, we will find that there is no instance of a storing of a surplus force, whether of heat, electricity, formative, or this that we call nerve force, while we have abundant evidence that each of these is produced as required. But if it was necessary to store a surplus of nerve force, the sympathetic ganglion certainly does not present that form and anatomical arrangement that would adapt it to the purpose.

791. Dr. Dalton, in his treatise on physiology, found it impossible to separate the functions of the sympathetic and spinal systems, and as regards the mixed action he draws the following conclusions:

"1. *Reflex actions taking place from the internal organs, through the sympathetic and cerebro-spinal systems, to the voluntary muscles and sensitive surfaces.*—The convulsions of young children are often owing to the irritating undigested food in the intestinal canal. Attacks of indigestion are also known to produce temporary amaurosis, double vision, strabismus, and even hemiplegia. Nausea and a diminished or capricious appetite are often prominent symptoms of early pregnancy, induced by the peculiar condition of the uterine mucous membrane

"2. *Reflex actions taking place from the sensitive surfaces, through the cerebro spinal and sympathetic systems, to the involuntary muscles and secreting organs.*—Imprudent exposure to cold and wet will often bring on a diarrhea. Mental and moral impressions, conveyed through the special senses, will affect the motions of the heart, and disturb the processes of digestion and secretion. Terror, or absorbing interest of any kind, will produce dilatation of the pupil, and communicate in this way a peculiarly wild and unusual expression to the eye. Disagreeable sights or odors, or even unpleasant occurrences, are capable of hastening or arresting the menstrual discharge, or of inducing premature delivery.

"3. *Reflex actions taking place through the sympathetic system from one part of the internal organs to another.*—The contact of food with the mucous membrane of the small intestine excites a

peristaltic movement in the muscular coat. The mutual action of the digestive, urinary, and internal generative organs upon each other, takes place through the medium of the sympathetic ganglia and their nerves. The variations of the capillary circulation in different abdominal viscera, corresponding with the state of activity or repose of their associated organs, are to be referred to a similar nervous influence. These phenomena are not accompanied by any consciousness on the part of the individual, nor by any apparent intervention of the cerebro-spinal system."

792. I have made the above quotation from Dr. Dalton for two purposes, namely, to show the common tendency to confound physiological and pathological processes, and as an additional illustration of the associated action of the spinal and ganglionic nervous systems in that function that is termed *sympathy*.

793. I think we have abundant facts both in physiology and pathology to prove that the sympathetic system of nerves controls the vegetative functions, *digestion, blood-making, the circulation of the blood, nutrition,* and *secretion;* and that such control, in a normal condition, is simply to associate these functions in all parts of the body for the benefit of the whole, and for its more perfect adaptation to the various states in which it may be placed, and the various activities required of it.

794. This function is called *sympathy*, and yet, as we have already seen, the term is applied to additional nervous action. If we are to retain the term in pathology, we will have to recognize two sources of such action. The one, cerebro-spinal, is conscious sympathy, and is always evidenced by sensation. The other is unconscious sympathy, and has relation to the organic acts above described. That there is a necessity of such associated action must be evident, as these vegetative functions are to a great extent dependent upon one another; and that it should extend to control the physical condition of every organ and part is absolutely essential to the varied activities which the animal body is constantly exhibiting. In the vegetable kingdom nothing of this kind is necessary, for the growth is in one direction, that of increase, and is not antagonized by waste; while in the ani-

mal body death of organic structure is necessary to motion or any activity, and if health be maintained, it must be balanced by increased nutritive activity of the particular part.

795. In considering the lesions of sympathetic innervation by the common standard of excess, defect, and perversion, we will have to examine it in its relation to digestion, blood-making, circulation, nutrition, and secretion, and that common function, sympathy.

796. *Excess* of sympathetic innervation in the circulation of the blood is a very prominent feature in many acute diseases. This excess may either denote strength, as in sthenic fevers and inflammation, or be associated with debility of the circulatory system, as in the common fevers of our country, or the sthenic fevers and inflammations. Those remedies that control this lesion of circulation act through the sympathetic system. The direct sedatives in small doses give increased strength, but lessen excitement, while some of them, as veratrum, in large doses, act as powerful depressants of this system of nerves. Indirect sedation and control of the heart's action is accomplished by remedies that act powerfully on some organ, supplied by the sympathetic, and which action is followed by depression. Thus lobelia is sedative by its depressing action upon the stomach; some cathartics by their depressing influence on the bowels; and occasionally profuse diaphoresis or diuresis will have the same result.

797. Another marked *excess* is noticed in excessive secretion from the various excretory organs, when there is no lesion of structure or relation to account for it. We have examples of this in some cases of diarrhœa (choleraic), in diabetes insipidus, and in increased secretion from the stomach, liver, and other parts. It has been contended by some, that Asiatic cholera was a lesion of the sympathetic, and I am inclined to take the same view, as remedies known to influence this portion of the nervous system, directly or indirectly, are the only ones that are found beneficial.

798. Excess of sympathy between parts influencing the vegetative functions, is of common occurrence. The lesions of diges-

tion and blood-making that arise from slight uterine disease, is a marked example of this. Many times we see serious constitutional disturbance follow a local lesion of the uterus, or reproductive system, which is so slight, that if of any other part it would scarcely be noticed. The same sympathy is manifested in disease of the brain, lungs, kidneys, and some other parts.

799. *Defect* is the common lesion that we meet with, and forms an element in a large number of diseases. Defective digestion is not unfrequently partially, and in some cases wholly, due to deficient innervation; and many of the remedies that improve this function act through the nervous system. Defect in blood-making, both as regards quantity and quality, is undoubtedly dependent upon want of normal innervation through the sympathetic. It is the same with the circulation of the blood, nutrition and secretion. If the reader will turn back to where these functions were considered, he will obtain the necessary treatment.

800. *Perversion* is not so easily defined; and though we have reason to attribute many of the anomalies of function and nutrition to this source, our information is yet too meager to establish it as a fact. There is a large list of remedies that undoubtedly act upon the sympathetic system of nerves, and to a very considerable extent through this on the processes of life. Indeed, we might set up a claim that all the important remedies act in this way. A few of the more prominent of this class may be named: veratrum, aconite, gelseminum, rhus, bryonia, sticta, digitalis, belladonna, ergot, calabar bean, macrotys, pulsatilla, collinsonia, valerian, drosera. Then there is a class that act both upon the spinal and sympathetic system, as strychnia, quinia, and other of the bitter tonics; while a third class influence the entire nervous system, as opium and its alkaloids. The sympathetic system is also influenced by those remedies which aid nutrition of nerve structure, and by that well regulated exercise of function which always gives nutrition and strength.

IRRITABILITY AND TONICITY.

801. Dr. Williams, and other authors, describe certain properties of living tissue as irritability and tonicity, and describe the lesions of these as they do those of innervation, secretion, nutrition, etc. Though I regard both of these as but an expression of other functions heretofore described, we will examine them as the result of associated functional and structural activities.

IRRITABILITY.

802. Dr. Williams says: "Irritability, irritable contractility, or the property of contracting on the application of certain stimuli, is the distinctive characteristic of muscular fiber." If we examine the matter closely, however, this property wi'l be found to be only that normal disposition to the performance of function which is possessed alike by all tissues. The function of muscular fiber is contractility, and this is performed under the influence of the nervous system, or analogous stimuli. But is it any different from the function of secreting structure, which is also performed under the influence of the nervous system or other stimuli? I think it much more reasonable to regard all tissue as having such vital property as may enable it to perform its use in the body, and respond to such impressions as may be necessary to give those higher activities of which man is capable.

803. Regarding such property as common to all tissue, the conditions necessary to its normal development will be as follows: A normal formative force and cell production, hence, a high development of tissue. To this end, a sufficient supply of food, good digestion and assimilation, forming good blood, and a good circulation, carrying it to the parts to be supplied. There is one other condition of equal importance, namely, the condition of *activity;* for, as we have heretofore seen, the performance of any function is the result of its activity; and conversely, that without activity, this property of tissue is lost. We may sum up the

conditions necessary for *functional irritability* very briefly as follows: *normal nutrition* and *functional activity.*

804. There can be no such lesion as an *excess* of this purely vital function, for that would be only an increased capacity for use, which comes from increased activity and nutrition; and we must regard the excess of *muscular irritability,* spoken of by Dr. Williams, as a lesion of the nervous system, rather than of the muscular fiber.

805. *Defect* of this property of irritability is a very common element of disease, and is met with, to a greater or less extent, in all cases where there is enfeebled functional activity. We appreciate that condition of tissue, whether muscular, secreting, or nervous, in which it has lost this vital property, and we correctly attribute it to a lesion of nutrition. It is hardly necessary to give examples of this, they are so common and familiar. As belonging to muscular tissue, the continually increasing debility in acute and many chronic diseases, is a marked example. That this debility is not entirely due to deficient innervation is evidenced by the slow and enfeebled response to any stimulus. There are some chronic diseases in which this is a marked element of the debility, and the sufferer himself will speak of this want of irritability in his muscles. The defect is more marked in the frequent exhaustion of such functional irritability in secreting organs, and the non-striated muscular fiber. We recognize this fact in our common expressions of a torpid stomach, torpid liver, torpid bowels, torpid skin, torpid kidneys, etc.; and though here the torpor is more or less owing to deficient nervous supply, yet experience proves to us that there is also a loss of the power of response.

806. If this property of response is dependent upon active renewal of tissue and exercise, the treatment of such defect becomes very plain. By the aid of means already described, we increase the general nutritive activity of the entire body; and by certain special remedies, which have an elective action on particular parts, we stimulate an increased circulation, increased nutrition,

and increased functional activity in the part most particularly affected.

807. Let it be recollected that moderate exercise of a part is the most certain means for the development of this functional irritability. Tissue attains this power of response just in proportion to its legitimate use, as has been frequently stated in these pages. If an increased irritability of muscles is necessary, let the person be exercised. If we want increased power of the stomach, in addition to medicinal means, we cultivate it by use; if there is habitual constipation, from loss of this irritability in the muscular coat of the bowels, a cure is attained by persevering attention to the use of the power already possessed.

TONICITY.

808. Dr. Williams gives an excellent description of tonicity, as it is generally regarded by the profession, and which I will quote: "Tonicity, or tone, is a property possessed by all muscular structures, whether voluntary or involuntary, as well as some other textures which are hardly accounted muscular. It is expressed by a tendency to slow, moderate, and permanent contraction, not essentially terminating in relaxation; it keeps the parts in which it resides in a certain degree of tension. It is seen in the retraction of a living muscle when divided in the operation of amputation of a limb, which takes place to a considerably greater extent than it would in a dead muscle. It holds muscles and limbs in their places when at rest, and out of their places when dislocated; when one set of muscles is paralyzed, the tone of their antagonists draws the parts in connection with them in an opposite direction, as seen in paralysis of the portio dura of one side of the face. A similar property is exhibited by the intestinal tube, the urinary bladder, and the air-tubes. It also resides in the middle coats of the arteries, and gives these tubes a constant tendency to contract on their contents. This is shown when they cease to receive blood from the heart; their tonicity

then narrows their caliber, and hence they are always found empty after death. It also adapts them to different degrees of fullness, and yet maintains in their walls the tension that is favorable to equality in the motion of the blood. Tonicity performs an important part in the phenomena both of health and disease.

"It has been stated that tonicity is quite distinct from irritability, and that, although irritable fibers possess tone, tonic textures are not irritable. This, however, is not true with regard to the arteries; for I have many times distinctly seen them *slowly* contract, and *remain* contracted, at a point to which an irritant (mechanical, chemical, or electrical) has been applied. The discovery, by Henk, of a structure distinctly muscular in arteries, confirms this observation. I have, in like manner, satisfied myself of the irritability of the air-tubes, which move more rapidly under a stimulus than the arteries; the intestines do the same in a still higher degree, but still inferior to the œsophagus and voluntary muscles, the contractions of which, on the application of a stimulus, are abrupt and immediately followed by relaxation. So far, then, it appears that the slow contraction of tonicity is influenced by the same agents which excite irritability; but there is another agent (temperature) which seems to affect them differently. Cold, which impairs irritability, increases tonicity. Under the influence of cold, vessels generally, but especially arteries, shrink in size very remarkably; and the muscles and other textures, under the same circumstances, present a firmness and rigor of tonic contraction, which impede the quickness of motion that characterizes the highest degrees of irritability. Under the influence of heat, on the other hand, muscles are more relaxed and more irritable; the pulsations of the heart are made by it more frequent."

809. The property above described as belonging to muscular structures is evidently that just described as irritability; and in the examples given the action is undoubtedly due to nervous influence. There are also mistakes, in fact, which need to be rec-

tified. The contraction of a muscle after amputation is so evidently the result of nervous irritation, that I wonder that it should ever be brought forward as the result of tonicity. Again, a state of moderate contraction is the normal condition of muscles, and is dependent upon the excitation of the circulation of blood through them, and the change of tissue that is taking place. Yet we should not like to designate this property as tonicity, for it is not possessed by the muscular tissue, except under these circumstances. Again, it is stated that cold impairs irritability, while heat increases it, but if irritability is the property possessed by muscular fiber of responding to stimuli, the opposite is the case with the moderate degrees of heat and cold spoken of.

810. What, then, is tonicity? I hold it to be a *state* not a *property*, and defines the sum of the vital properties of all soft tissues. Experience has determined that a certain degree of compactness and resiliency is necessary for the normal performance of any and all functions, and therefore this has been taken as the measure of tonicity. This compactness and resiliency is dependent upon a free circulation of good blood, and upon active nutrition, which is the real basis of functional activity; and if the physician will analyze his thoughts on this subject, he will find a good circulation and normal nutrition in his ideal of tonicity. A patient is presented with soft, flaccid muscles, and, if we had no other evidence, we should say that his digestion was impaired, his circulation feeble, and nutrition of texture slow. When we speak of a want of tone of the stomach, bowels, skin, etc., we have reference not to the condition of the muscular fiber only, but to the entire state of the part, its circulation, nutrition, and capacity for functional activity, whether it be secretion or contraction.

811. Again, if we examine the action of that class of remedies called *tonics*, we will find that they act by improving the appetite and digestion, the formation of blood, its circulation, and by stimulating the nutritive processes. Restoratives and blood-making food are our best tonics, if the digestive organs are in condition to appropriate them.

812. I do not think it necessary here to speak of lesions of tonicity, for it is a state dependent upon other conditions which have already been considered in detail. It is a very important state, and when deficient leads certainly to feebleness and errors of function; and, in the treatment of disease, those remedies called tonics, and which, by increasing the appetite, digestion, circulation, and nutrition, thus giving the state called *tone*, are among our most important means.

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